

## AMENDMENT OF SOLICITATION

Page of Pages

1 / 6

1. AMENDMENT/MODIFICATION NO. <b>0003</b>	2. EFFECTIVE DATE <b>MAY 14, 2003</b>	
3. ISSUED BY  DEPARTMENT OF THE ARMY, BALTIMORE DISTRICT CORPS OF ENGINEERS P.O. BOX 1715 BALTIMORE, MARYLAND 21203-1715		
4. NAME AND ADDRESS OF CONTRACTOR (Name, street, county, State and ZIP Code)	4A. AMENDMENT OF SOLICITATION NO.  <b>DACW31-03-R-0012</b>	
	4B. DATED (SEE ITEM 5)  <b>APRIL 15, 2003</b>	
5. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS  The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers <b>is extended.</b> <b>DATE OF RECEIPT OF PROPOSAL SEE BELOW</b> Others must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods: (a) By completing items 4 and 8, and returning <u>1</u> copy of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of the amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.		
6. ACCOUNTING AND APPROPRIATION DATA (If required)  <b>NEVAL THOMAS ELEMENTARY SCHOOL, WASHINGTON, DC</b>		
7. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)  <b>SEE THE FOLLOWING PAGES</b>		
Except as provided herein, all terms and conditions of the document referenced in Item 4A, as heretofore changed, remains unchanged and in full force.		
8. NAME AND TITLE OF SIGNER (Type or print)	9. CONTRACTOR/OFFEROR  <u>(Signature of person authorized to sign)</u>	10. DATE SIGNED

GENERAL:

THE DATE AND TIME HAS BEEN EXTENDED TO 4:00 PM LOCAL TIME, MAY 23, 2003.  
REVISE BLOCK 13A OF THE SOLICITATION TO REFLECT THIS CHANGE.

SPECIFICATIONS:

1) Project Table of Contents – Section 15951: Change section title to read:  
“BACNET INTERNETWORKED CONTROL SYSTEM”.

2) Page 01000-7: Add the following paragraph to the end of this section.

“1.16 ENERGY STAR Performance Certification

As part of the one-year periodic warranty, operating, and maintenance service, the Contractor shall monitor, record, and submit necessary documentation to the United States Department of Energy, ENERGY STAR Program, to receive an honorary plaque certifying energy performance rating. Required documentation includes the building gross square footage, twelve months of actual energy consumption data, weekly hours of occupancy, the number of students, and the number of months in operation, the percentage of the building that is cooled, and the identification of food preparation facilities. Applications for the ENERGY STAR label require a letter of application, and an Official Statement of Energy Performance, validated by a licensed professional engineer. A sample of the Official Statement of Energy Performance is attached.”

3) Section 01050: Make the following changes to this section:

a) Page 01050-1, Paragraph 1.1.1: At the end of the Phase One paragraph, add the following sentences:  
“The Phase I cooling tower relocation shall be completed by August 19, 2003. Provide temporary cooling as necessary to support summer school operations when the existing cooling system is temporarily out of commission.”

b) Page 01050-1, Paragraph 1.2: Add the following sentences to the end of the paragraph: “Preliminary borings were also drilled by Schnabel Engineering Associates. Boring logs and locations taken are included.”

c) Page 01050-10, Paragraph 1.16: Delete this paragraph as originally issued and substitute the following:

“1.16

This section specifies the procedure for determination of time extensions for unusually severe weather. In order for the Contracting Officer to award a time extension under this clause, the following conditions must be satisfied: a) The weather experienced at the project site must be found to be unusually severe, that is, more severe than the adverse weather anticipated for the project location during any given month, b) The unusually severe weather must actually cause a delay to the completion of the project. The delay must be beyond the control and without the fault and negligence of the contractor.

#### 1.16.1: Anticipated Adverse Weather Delays

The following schedule of monthly anticipated adverse weather delays is based on National Oceanic and Atmospheric Administration (NOAA) or similar data for the project location and will constitute the base line for monthly weather time evaluations. The contractor's progress schedule must reflect these anticipated adverse weather delays in all weather dependent activities:

#### MONTHLY ANTICIPATED ADVERSE WEATHER DELAY WORK DAYS BASED ON (5) DAY WORK WEEK

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
4	5	6	7	6	6	6	5	2	5	4	3

#### 1.16.2: Impact

Upon acknowledgment of the Notice to Proceed (NTP) and continuing throughout the contract, the contractor will record on the daily CQC report, the occurrence of adverse weather and resultant impact to normally scheduled work. Actual adverse weather delay days must prevent work on critical activities for 50 percent or more of the contractor's scheduled work day. The number of actual adverse weather delay days shall include days impacted by adverse weather, be calculated chronologically from the first to the last day of each month, and be recorded as full days. If the number of actual adverse weather delay days exceed the number of days anticipated in paragraph 1.16.1, above, the Contracting Officer will convert any qualifying delays to calendar days, giving full consideration for equivalent fair weather work days, and issue a modification, in accordance with the contract terms."

- 4) Section 01330: Delete the submittal register, ENG Form 4288, at the end of the section and substitute the attached submittal register, ENG Form 4288, dated May 12, 2003, at the end of the section.
- 5) Section 07416, Paragraph 2.1: Add the following phrase after the Manufacturer's name listed as the "Basis of Design" for this product: "... and approved equal."
- 6) Section 08716, Paragraph 2.1: Add the following phrase after the Manufacturer's name listed as the "Basis of Design" for this product: "... and approved equal."
- 7) Section 09960, Paragraph 2.1.1: Add the following phrase after the Manufacturer's name listed as the "Basis of Design" for this product: "... and approved equal."
- 8) Section 10900, Paragraph 2.1.1: Add the following phrase after the Manufacturer's name listed as the "Basis of Design" for this product: "... and approved equal."
- 9) Section 11490, Paragraph 2.1.1: Add the following phrase after the Manufacturer's name listed as the "Basis of Design" for this product: "... and approved equal."
- 10) Section 12355, Paragraph 2.1.1: Add the following phrase after the Manufacturer's name listed as the "Basis of Design" for this product: "... and approved equal."

11) Section 12492, Paragraph 2.2: Delete “To be determined.” and substitute the following:

“Curtain fabric shall be washable 24-ounce fire retardant cotton velour, conforming to state of California NPFA 701, Small Scale requirements. Stage curtains shall consist of a valence and a bi-parting main traveler, with standard grommet-in pleats and furnished with standard S-hooks. Color shall be selected from manufacturer standard color selections, as manufactured by the Major Theater Equipment Corporation of South Boston, MA, or approved equal.”

12) Page 15645-9: Add the following paragraph:

“2.7.3:

”Closed Circuit Cooling Tower Management System (CMTS):

Cooling tower manufacturer shall provide CMTS consisting of:

- \* 4- Compartment NEMA 3R enclosure (wall mount)
- \* Individual 460/3/60 power feed per power panel
- \* Three (3) 30-HP VFD’s for cooling tower fans
  - Input non-fused disconnect
  - Control transformer with fused primary and secondary – 115/1/60p0
  - Selector switches and run lights
  - Basin heater contractor branch fuses, H-O-A & ON indicator
  - Manual by-pass
  - One (1) system controller
  - Input disconnect
  - 10” Color touch screen operator interface/controller
  - I/O subsystem rated to 70°C
  - Logic
    - a) Tower cell selection shall based on number of pumps in operation
    - b) Fan sequencing and speed control based on glycol condenser water temperature
    - c) Alternation of tower cells
    - d) Heater contactor management
    - e) Spray pump control
    - f) Graphic overview display
    - g) Alarm detection and annunciation
    - h) Trend display of process variables
    - i) Equipment run-time display
    - j) BAS interface
    - k) Tower valve selector
    - l) Tower Hi and Lo water level alarms
    - m) Hi and Lo condenser water temperature alarms
- \* Tower control valves on inlet and outlet glycol connections
- \* Temperature and flow signals to be furnished by others
- \* UL labeled panel”

13) Page 15895-5, Paragraph 2.6: Delete the parentheses phrase “(Not in this contract)” where Section 15951 is referenced.

14) Section 15951: Delete this section as originally issued and substitute therefore the attached same like-numbered specification section.

15) Page 15995-1, Paragraph 1.2: Delete the parentheses phrase “(Not in this contract)” where Section 15951 is referenced.

DRAWINGS:

16) Sheet A404: Revise this plate that was attached with Amendment No. 0002 in accordance with the attached Sketch ADD-a-09 dated 5/12/2003.

17) Sheet A406: Revise this plate that was attached with Amendment No. 0002 in accordance with the attached Sketches ADD-A-10 and ADD-A-11, dated 5/12/2003.

18) Sheet A411: Delete this as originally issued and substitute with same like-numbered Sheet A411 dated 05/12/03.

19) Sheet A501: Revise this plate in accordance with the attached Sketches ADD-A-12 and ADD-A-13 dated 5/12/2003.

20) Sheet C101: Delete this as originally issued and substitute with same like-numbered Sheet C101 dated 05/12/03.

21) Sheet C402: Revise this plate in accordance with the attached Sketches ADD-C-05 and ADD-C-06 dated 5/12/2003.

22) Sheet C500: Revise this plate in accordance with the attached Sketch ADD-C-07 dated 5/12/2003.

23) Sheet FA101: Delete this plate as originally with drawing sheet C101 dated 04/29/03.

24) Sheet FA102: Omit drawing sheet C101 dated 01/17/03 and replace with drawing sheet C101 dated 04/29/03.

25) Sheet FA402: Add drawing sheet FA402, dated 05/12/03.

26) Sheet M403: Add drawing sheet M403 dated 05/12/03.

27) Sheet M404: Add drawing sheet M404 dated 05/12/03.

28) Sheet M405: Add drawing sheet M405 dated 05/12/03.

29) Sheet T001: Revise this plate that was attached with Amendment No. 0002 in accordance with the attached Sketch ADD-T-02, dated 5/12/2003.

ATTACHMENTS:

Submittal Registers

Specification Section 15951

Site Borings

Energy Star Certification Sample Form

Sketch ADD-A-09

Sketch ADD-A-10

Sketch ADD-A-11

Sketch ADD-A-12

Sketch ADD-A-13

Sketch ADD-C-05

Sketch ADD-C-06

Sketch ADD-C-07

Sketch ADD-T-02

# Appendix A. Example Copy of the Statement of Energy Performance



## STATEMENT OF ENERGY PERFORMANCE Main Street Building - 11/10/1999

### Building

Main Street Building  
1234 Main Street  
Washington, DC 20005  
Gross Building Area (ft<sup>2</sup>): 498,000  
Year Built: 1989

### Building Owner

Angelo Tippy  
1602 Independence Street  
Washington, DC 20005  
Contact Name: Jean-Luc Cretienne  
Contact Phone: 202-555-1212

### Building Space Use Summary

	Area: (ft <sup>2</sup> )	Occupants	Occupancy Hours/Week	Computers
Office:	493,346	1,215	102	1,200
Computer Room/Data Center:	4,654	-	168	-
Parking Garage (attached):	135,000	-	168	-

### Site Energy Use Summary (10/13/98 to 10/11/99)

Electricity (kBtu)	Total Energy (kBtu)
33,414,330	33,414,330

### Normalized Benchmark Data

	ENERGY STAR	Your Building
Benchmarking Score:	75	77
Energy Intensity:		
Site (kBtu/ft <sup>2</sup> -yr):	57	55
Source (kBtu/ft <sup>2</sup> -yr):	171	166
Emissions:		
CO <sub>2</sub> (1000 lbs/yr):	21,154	20,527
SO <sub>2</sub> (1000 lbs/yr):	140	136
NO <sub>x</sub> (1000 lbs/yr):	34	33
Energy Cost:		
(\$):	842,161	817,189
(\$/ft <sup>2</sup> -yr):	1.33	1.29

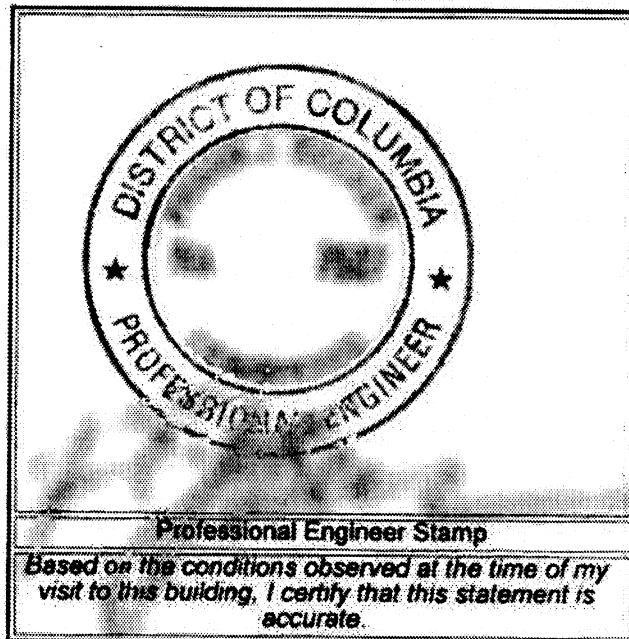
### Indoor Environment Criteria

INDOOR AIR POLLUTANTS CONTROLLED?  
ADEQUATE VENTILATION PROVIDED?  
THERMAL CONDITIONS MET?  
ADEQUATE ILLUMINATION PROVIDED?

PASS  
PASS  
PASS  
PASS

### Professional Verification

Jason Jeter, Professional Engineer  
Jeter, James and Jones Engineering  
Street Address: 1701 Irving Street  
City, State: Washington, DC 20036  
Phone Number: 202-123-1234



## **SUBSURFACE INVESTIGATION PROCEDURES**

### 1. **Test Borings – Hollow Stem Augers**

The borings are advanced by turning an auger with a center opening of 2 ¼ to 3 ¼ inches. A plug device blocks off the center opening while augers are advanced. Cuttings are brought to the surface by the auger flights. Sampling is performed through the center opening in the hollow stem auger, by standard methods, after removal of the plug. Usually, no water is introduced into the boring using this procedure.

### 2. **Standard Penetration Tests**

Numbers after description of the soil strata indicate the minimum and maximum penetration resistance, or N value, recorded in each stratum. N values indicated the penetration resistance in blows per foot of a standard 2 inch O.D., 1 3/8 inch I.D. sampling spoon driven with a 140 pound hammer falling 30 inches per ASTM D-1586. After an initial set of 6 inches to assure the sampling spoon is in undisturbed material, the number of blows required to drive the sampler an additional 12 inches is generally taken as the N value.

### 3. **Boring Locations and Grades**

The soil boring locations were located in the field by Schnabel personnel and ground surface elevations were estimated from a site plan provided to us by EYP.



# SCHNABEL ENGINEERING ASSOCIATES

## Consulting Geotechnical Engineers

### IDENTIFICATION OF SOIL

#### I. DEFINITION OF SOIL GROUP NAMES

ASTM D-2487-83

			Symbol	Group Name
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels — More than 50% of coarse fraction retained on No. 4 sieve Coarse, 3/4" to 3" Fine, No. 4 to 3/4"	Clean Gravels Less than 5% fines	GW	Well graded gravel
			GP	Poorly graded gravel
		Gravels with Fines More than 12% fines	GM	Silty gravel
			GC	Clayey gravel
	Sands — 50% or more of coarse fraction passes No. 4 sieve Coarse, No. 10 to No. 4 Medium, No. 40 to No. 10 Fine, No. 200 to No. 40	Clean Sands Less than 5% fines	SW	Well-graded sand
			SP	Poorly graded sand
		Sands with Fines More than 12% fines	SM	Silty sand
			SC	Clayey sand
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays — Liquid Limit less than 50 Low to medium plasticity	Inorganic	CL	Lean clay
			ML	Silt
	Silts and Clays — Liquid Limit 50 or more Medium to high plasticity	Organic	OL	Organic clay Organic silt
			CH	Fat clay
			MH	Elastic silt
		Organic	OH	Organic clay Organic silt
Highly Organic Soils	Primarily organic matter, dark in color, and organic odor		PT	Peat

#### II. DEFINITION OF MINOR COMPONENT PROPORTIONS

Minor Component	Approximate Percentage of Fraction by Weight
Adjective Form	
Gravelly, Sandy	30% or more coarse grained
With	
Sand, Gravel	15% or more coarse grained
Silt, Clay	5% to 12% fine grained
Trace	
Sand, Gravel	Less than 15% coarse grained
Silt, Clay	Less than 5% fine grained

#### III. GLOSSARY OF MISCELLANEOUS TERMS

**SYMBOLS** — Unified Soil Classification Symbols are shown above as group symbols. Use A Line Chart for laboratory identification. Dual symbols are used for borderline classifications.

**BOULDERS & COBBLES** — Boulders are considered rounded pieces of rock larger than 12 inches, while cobbles range from 3 to 12 inch size.

**DISINTEGRATED ROCK** — Residual rock material with a standard penetration resistance (SPT) of more than 60 blows per foot, and less than refusal. Refusal is defined as a SPT of 100 blows for 2" or less penetration.

**ROCK FRAGMENTS** — Angular pieces of rock, distinguished from transported gravel, which have separated from original vein or strata and are present in a soil matrix.

**QUARTZ** — A hard silica mineral often found in residual soils

**IRONITE** — Iron oxide deposited within a soil layer forming cemented deposits

**CEMENTED SAND** — Usually localized rock-like deposits within a soil stratum composed of sand grains cemented by calcium carbonate or other materials.

**MICA** — A soft plate of silica mineral found in many rocks, and in residual or transported soil derived therefrom.

**ORGANIC MATERIALS** (Excluding Peat):

Topsoil - Surface soils that support plant life and which contain considerable amounts of organic matter:

Organic Matter - Soil containing organic colloids throughout its structure;

Lignite - Hard, brittle decomposed organic matter with low fixed carbon content (a low grade of coal).

**FILL** — Man made deposit containing soil, rock and often foreign matter.

**PROBABLE FILL** — Soils which contain no visually detected foreign matter but which are suspect with regard to origin

**LENSES** — 0 to 1/2 inch seam of minor soil component.

**LAYERS** — 1/2 to 12 inch seam of minor soil component.

**POCKET** — Discontinuous body of minor soil component

**COLOR SHADES** — Light to dark to indicate substantial difference in color.

**MOISTURE CONDITIONS** — Wet, moist, or dry to indicate visual appearance of specimen.

FOOTE  
STREET, NE  
(90 ft. Wide PUBLIC STREET)

SQUARE 5041

GRANT  
STREET, NE  
(90 ft. Wide PUBLIC STREET)

ANACOSTIA

AVENUE, NE

(90 ft. Wide PUBLIC STREET)

B-1

B-2

B-3

B-4

LEGEND



APPROXIMATE SOIL BORING LOCATION



Boring Contractor: GEOLOGICAL TECHNOLOGIES INC.

Boring Foreman: Kurt Feldmeyer

Drilling Method: 2-1/4 I.D. Hollow Stem Auger

Drilling Equipment: Acker ADII

SEA Representative: Stew Bennie

Dates Started: 8/29/01 Finished: 8/29/01

Location: See Boring Location Plan

Ground Surface Elevation: 17.4± (feet)

Groundwater Observations

	Date	Time	Depth	Casing	Caved
Encountered	8/29	—	13.0'	—	—
Completion	8/29	—	12.0'	—	—
Casing Pulled	8/29	—	12.0'	—	32.0'
24 hours	8/30	—	6.0'	—	—

DEPTH (ft)	STRATA DESCRIPTION	CLASS.	ELEV. (ft)	STRATUM	SAMPLING DEPTH	DATA	TESTS	REMARKS
0.8	Topsoil silty sand FILL with rock fragments, moist, black	SM	16.6	A	2+4+2			
					1+WOH+12			
					5 WOH+18			
					1+1+1			
	possible piece of wood or rock in front of spoon @ 11.0 feet				13+17+22			
					1+WOH+12			
					20 2+3+11			
24.0	silty SAND with gravel, moist, light brown	SM	-6.6	B	25 6+1+1			
28.5	silty CLAY with sand and gravel fragments, moist, gray	CL	-11.1		30 2+3+4			
					35 1+3+2			
					40 3+4+6			
40.0	BOTTOM OF BORING @ 40.0 FT.		-22.6					

Comments:  
WOH = Weight of Hammer

TEST BORING LOG BLOGA.GPJ SCHNABEL.GDT 9/6/01

Boring Contractor: GEOLOGICAL TECHNOLOGIES INC.

Boring Foreman: Kurt Feldmeyer

Drilling Method: 2-1/4 I.D. Hollow Stem Auger

Drilling Equipment: Acker ADII

SEA Representative: Stew Bennie

Dates Started: 8/29/01 Finished: 8/29/01

Location: See Boring Location Plan

Ground Surface Elevation: 16.5± (feet)

Groundwater Observations

	Date	Time	Depth	Casing	Caved
Encountered	8/29	—	13.0'	—	—
Completion	8/29	—	9.0'	—	—
Casing Pulled	8/29	—	9.0'	—	30.0'
24 hours	8/30	—	7.0'	—	—

DEPTH (ft)	STRATA DESCRIPTION	CLASS.	ELEV. (ft)	STRATUM	SAMPLING		TESTS	REMARKS
					DEPTH	DATA		
0.8	Topsoil silty sand FILL with rock fragments, moist, orangish-brown	ML	15.7	A	3+4+7			PVC standpipe set at 18.5/1.5' sticking out of ground
					8+9+24			
					5 2+1+1			
					1+2+2			
					10 12+33+50			
					15 3+3+3+10			
				B	20 1+3+2			
					25 2+5+3			
28.5	SILT with sand and gravel, wet, light orangish-brown	ML	-12.0		30 3+4+7			
					35 3+9+7			
40.0	BOTTOM OF BORING @ 40.0 FT.		-23.5		40 7+9+13			

TEST BORING LOG BLOGA.GPJ SCHNABEL.GDT 9/5/01

Comments:

Boring Contractor: GEOLOGICAL TECHNOLOGIES INC.

Boring Foreman: Kurt Feldmeyer

Drilling Method: 2-1/4 I.D. Hollow Stem Auger

Drilling Equipment: Acker ADII

SEA Representative: Stew Bennie

Dates Started: 8/29/01 Finished: 8/29/01

Location: See Boring Location Plan

Ground Surface Elevation: 16.1± (feet)

Groundwater Observations

	Date	Time	Depth	Casing	Caved
Encountered	8/29	---	11.0'	---	---
Completion	8/29	---	11.0'	---	---
Casing Pulled	8/29	---	11.0'	---	33.0'
24 hours	8/30	---	9.0'	---	---

DEPTH (ft)	STRATA DESCRIPTION	CLASS.	ELEV. (ft)	STRATUM	SAMPLING DEPTH	DATA	TESTS	REMARKS
0.8	Topsoil	ML	15.3	A		3+7+8		
	silt with sand and rock fragments, FILL, moist, black					4+7+25		
	piece of concrete @ 5.0 feet				5	50/1"		
						6+2+2		
					10	24+16+13		
					15	1+1+1		
		SM	-7.4	B	20	1+1+1		
23.5	silty SAND with gravel, wet, light brown				25	12+20+21		
					30	21+50+50		
					35	11+13+21		
39.0	silty CLAY with sand and trace gravel fragments, wet, purple	CL	-22.9	C	40	7+9+19		
40.0	BOTTOM OF BORING @ 40.0 FT.		-23.9					

TEST BORING LOG BLOGA.GPJ SCHNABEL.GDT 9/6/01

Comments:

Boring Contractor: GEOLOGICAL TECHNOLOGIES INC.

Boring Foreman: Kurt Feldmeyer

Drilling Method: 2-1/4 I.D. Hollow Stem Auger

Drilling Equipment: Acker ADII

SEA Representative: Stew Bennie

Dates Started: 8/30/01 Finished: 8/30/01

Location: See Boring Location Plan

Ground Surface Elevation: 16.1± (feet)

Groundwater Observations

	Date	Time	Depth	Casing	Caved
Encountered	8/30	—	10.0'	—	—
Completion	8/30	—	10.0'	—	—
Casing Pulled	8/30	—	10.0'	—	—

DEPTH (ft)	STRATA DESCRIPTION	CLASS.	ELEV. (ft)	STRATUM	SAMPLING DEPTH	DATA	TESTS	REMARKS
0.7	Topsoil		15.4		3+5+8			
	silty sand FILL with rock fragments, moist, light brown				WOH+18			
7.5	silty sand FILL with rock fragments, wet, black		8.6	A	5 9+13+23			
					10 3+4+6			
					10 4+6+6			
					15 4+3+5			
18.5	silty SAND with gravel, wet, light brown	SM	-2.4		20 12+13+17			
23.5	silty CLAY with sand and gravel fragments, wet, gray	CL	-7.4	B	25 5+6+5			
					30 6+7+9			
33.5	silty SAND with gravel, wet, light brown	SM	-17.4		35 17+13+17			
38.5	fat CLAY with sand and gravel fragments, stiff, moist, purple		-22.4	C	40 5+5+7			
40.0	BOTTOM OF BORING @ 40.0 FT.		-23.9					

TEST BORING LOG BLOGA.GPJ SCHNABEL GDT 9/6/01

Comments:

WOH = Weight of Hammer

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N / R E V I E W I N G	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	A C T I O N  C O D E	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	A C T I O N  C O D E	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01000	SD-01 Preconstruction Submittals														
			Title Evidence														
			Invoice Copies														
			Payment Evidence														
			Photographs	1.12													
			Hazmat Materials	1.15													
			SD-03 Product Data														
			Cost or Pricing Data	1.8													
			Equipment Data	1.9													
			SD-10 Operation and Maintenance Data														
			O and M Data	1.10													
			Commissioning Activity for HVAC	1.4.5	G AR												
		01050	SD-01 Preconstruction Submittals														
			Shut Down Utility Services	1.5.3	G AR												
			Advance Notice	1.5.4													
			Checklist		G AR												
			Control Records	1.12													
			SD-05 Design Data														
			Summarization	1.15.4													
			SD-07 Certificates														
			Operations Statement	1.13.2													
		01060	SD-01 Preconstruction Submittals														
			Safety Supervisor	1.4	G AR												
			Activity Phase Hazard Analysis Plan	1.4	G AR												

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION	PARAGRAPH	CLASSIFICATION / REVIEWER	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
						SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	ITEM SUBMITTED (d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01060	Site Safety and Health Plan		G AR												
			Qualifications		G AR												
			SD-02 Shop Drawings														
			Work Layout Drawings		G AR												
			SD-07 Certificates														
			Language Certification	1.4													
			SD-09 Manufacturer's Field														
			Reports														
			Activity Hazard Analyses in		G AR												
			accordance with EM 385-1-1,														
			paragraph 01.A.09														
			Outline Report														
			OSHA Log														
			Slte Control Log		G AR												
		01200	SD-04 Samples														
			Sample Tags	1.7.2.2													
		01210	SD-01 Preconstruction Submittals														
			Proposal:		G AR												
			Invoices:		G AR												
		01320	SD-01 Preconstruction Submittals														
			Initial Project Schedule		G AR												
			Preliminary Project Schedule		G AR												
			Periodic Schedule Updates		G AR												
			Qualifications	1.3	G AR												
			Narrative Report	3.5.2	G AR												
			Schedule Reports	3.5.4	G AR												



# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N  G O V C L A S S I F I C A T I O N	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
						SUBMIT	BY	BY	A C T I O N  C O D E	DATE OF ACTION		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	A C T I O N  C O D E	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01356	SD-07 Certificates														
			Mill Certificate or Affidavit	2.1.3													
		01451	SD-01 Preconstruction Submittals														
			CQC Plan	3.2	G AR												
			Phase Notification														
			Request		G AR												
			CQC Mgr Qualification		G AR												
			SD-05 Design Data														
			Notification of Changes	3.2.4													
			Punchlist	3.8.1													
			Minutes	3.3													
			SD-06 Test Reports														
			Tests	3.7.1													
			Documentation	3.9													
			Tests Performed	3.7.1													
			QC Records		G AR												
		01460	SD-01 Preconstruction Submittals														
			Site Security Plan	1.5	G AR												
		01510	SD-01 Preconstruction Submittals														
			Noise	1.10	G AR												
			SD-02 Shop Drawings														
			Temporary Electrical Work		G AR												
		01520	SD-01 Preconstruction Submittals														
			Prints with Original Negatives														
			Electronic Format	1.5	G AR												
			Videotape Recordings	1.6													

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N  G O V C L A S S I F I C A T I O N  S I T E C A R T H O W N R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
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(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01561	SD-05 Design Data														
			Facility Plan	1.9.4	G AR												
			Temporary Plan	1.9.5	G AR												
		01720	SD-11 Closeout Submittals														
			Progress Prints		G AR												
			Final Requirements	1.6	G AR												
			CADD Files														
		02115A	SD-03 Product Data														
			Work Plan	1.5.2	G AE												
			Qualifications	1.3	G AR												
			Salvage Rights	3.11.4													
			SD-06 Test Reports														
			Backfill Material	2.1	G AR												
			Tank Contents Verification	3.2	G AR												
			Soil Examination, Testing, and Analysis	3.9	G AR												
			Backfilling	3.10	G AR												
			Tank Closure Report	3.13	G AR												
		02220a	SD-03 Product Data														
			Work Plan	1.8.1	G AE												
			SD-07 Certificates														
			Demolition plan	1.8.1													
			Notifications	1.5.1													
			Notification of Demolition and Renovation forms	1.5.1													
			SD-11 Closeout Submittals														

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION						CONTRACTOR											
Neval Thomas Elementary School - Submittal Register Issue																	
A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY			MAILED TO CONTR/		
						SUBMIT	BY	BY	A C T I O N  C O D E	DATE OF A C T I O N		DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER			A C T I O N  C O D E
(a)	(b)	(c)	ITEM SUBMITTED (d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	REMARKS (r)
		02220a	Receipts	1.5.2													
		02300	SD-06 Test Reports														
			Testing	3.11													
			Earthwork														
			SD-07 Certificates														
			Testing	3.11	G												
		02315	SD-05 Design Data														
			Dewatering Plan. Copies of														
			plans and calculations for approval														
			not less than 60days before														
			installation:														
			SD-06 Test Reports														
			Testing														
			SD-07 Certificates														
			Testing Lab		G AE												
		02316	SD-05 Design Data														
			Dewatering Plan. Copies of														
			plans and calculations for approval														
			not less than 60 days before														
			installation.														
			SD-06 Test Reports														
			Field Density Tests														
			Testing of Backfill Materials														
			SD-07 Certificates														
			Testing Lab														
		02466	SD-02 Shop Drawings														

CONTRACT NO.

## Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR: SCHEDULE DATES	CONTRACTOR ACTION		APPROVING AUTHORITY		
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# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

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(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		02620	Filtration Geotextile	2.2	GED AE												
			Pipe for Subdrains	2.1													
			SD-07 Certificates														
			Filtration Geotextile	2.2													
			Pipe for Subdrains	2.1													
		02630a	SD-03 Product Data														
			Placing Pipe	3.3													
		02714	SD-03 Product Data														
			Plant, Equipment, Machines, and Tools														
			SD-06 Test Reports														
			Sampling and Testing	1.7													
			Approval of Materials	1.7.6	G AE												
			Evaluation	3.2.7	G AE												
			SD-07 Certificates														
			Testing Lab														
		02722	SD-03 Product Data														
			Plant, Equipment, Machines, and Tools	1.7													
			SD-06 Test Reports														
			Initial Tests		G AE												
			In-Place Tests														
			Coarse Aggregate	2.1.1	G ED												
			SD-07 Certificates														
			Testing Lab														
		02770	SD-05 Design Data														

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G # R A P H	C L A S S I F I C A T I O N  G O V E R N M E N T	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
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(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		02770	Concrete	2.1	G AE												
			SD-06 Test Reports														
			Field Quality Control	3.8													
		02791	SD-02 Shop Drawings														
			Shop Drawings	3.1.2.2	G AE												
			SD-03 Product Data														
			Synthetic Surfacing	2.2	G AE												
			Loose Fill Surfacing	2.3	G AE												
			Geotextile Fabric	2.4													
			Manufacturer's Qualification	1.7													
			Site Preparation	3.1													
			Temperature Limitation	3.2.1													
			Adhesive	2.2.8	G AE												
			Color	2.2.5	G AE												
			SD-04 Samples														
			Synthetic Surfacing	2.2	G AE												
			Loose Fill Surfacing	2.3	G AE												
			SD-06 Test Reports														
			Synthetic Surfacing	2.2													
			Sand	2.3.1													
			SD-07 Certificates														
			Materials	2.1													
			Manufacturer's Qualification	1.7													
			Manufacturer's Representative	1.11													
			Installer's Qualification	1.8													
			Substitution	3.1.4	G AE												

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION						CONTRACTOR											
Neval Thomas Elementary School - Submittal Register Issue																	
A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N  S I F I C A R T I C L E  O R I G I N A L	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS	
						SUBMIT (g)	BY (h)	MATERIAL NEEDED (i)	A C T I O N  C O D E  (j)	DATE OF ACTION (k)	DATE RCD FROM CONTR (l)	DATE FWD TO APPR AUTH/ (m)	DATE RCD FROM OTH REVIEWER (n)	A C T I O N  C O D E  (o)			DATE OF ACTION (p)
(a)	(b)	(c)	ITEM SUBMITTED (d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		02791	Child Safety and Accessibility Evaluation	3.5.1	G AE												
			SD-10 Operation and Maintenance Data														
			Maintenance Instruction	3.5.3													
		02821N	SD-02 Shop Drawings														
			Gates	2.1.2													
			Post spacing	3.2.1													
			Location of gate, corner, end, and pull posts	3.2.1													
			SD-03 Product Data														
			Chain-link fencing	2.1													
			Accessories	2.1.4													
			SD-06 Test Reports														
			Thickness of PVC coating	1.4.1													
			SD-07 Certificates														
			Fabric	2.1.1													
			Posts	2.1.3													
			Braces	2.1.3													
			Framing	2.1.2													
			Rails	2.1.3													
			Gates	2.1.2													
			Padlocks	2.1.7													
			SD-08 Manufacturer's Instructions														
			Fence	3.2													
		02870a	SD-02 Shop Drawings														

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N / R E V I S I O N	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR AUTH	REMARKS
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		02870a	Site Furnishing Standards	2.5	G AE												
			SD-03 Product Data														
			Site Furnishings	1.4	G AE												
			Installation	3.1	G AE												
			Materials	2.1													
			SD-04 Samples														
			Finish	2.4	G AE												
		02882	SD-02 Shop Drawings														
			Configuration	2.2.1	G AE												
			Shop Drawings	3.1.2.2	G AE												
			Fall Height	3.2.7	G AE												
			Finished Grade and Underground	3.1.1													
			Utilities														
			SD-03 Product Data														
			Equipment	2.2	G AE												
			Delivery, Storage and Handling	1.5													
			Manufacturer Qualification	1.8													
			Spare Parts	3.4.2													
			Materials	2.1													
			SD-04 Samples														
			Color	2.1.6	G AE												
			SD-06 Test Reports														
			Recycled Plastic	2.1.3													
			SD-07 Certificates														
			Materials	2.1													
			Manufacturer Qualification	1.8													



# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N S / C A R T E R I V O W N E R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY			DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	A C T I O N  C O D E	DATE OF ACTION	MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
						APPROVAL NEEDED	MATERIAL NEEDED	A C T I O N  C O D E	DATE OF ACTION	DATE FWD TO OTHER REVIEWER		DATE RCD FROM OTH REVIEWER	DATE OF ACTION							
						BY	BY	(j)	(k)	(l)		(m)	(n)	(o)						
(a)	(b)	(c)	ITEM SUBMITTED (d)	(e)	(f)	SUBMIT (g)	BY (h)	BY (i)	(j)	DATE OF ACTION (k)	DATE RCD FROM CONTR (l)	DATE FWD TO OTHER REVIEWER (m)	DATE RCD FROM OTH REVIEWER (n)	A C T I O N  C O D E (o)	DATE OF ACTION (p)	MAILED TO CONTR/  DATE RCD FRM APPR (q)	REMARKS (r)			
		02882	Installer Qualification	1.9																
			Manufacturer's Representative	1.12																
			Substitution	2.2.2	G AE															
			Play Event Modification	3.2.1	G AE															
			Child Safety and Accessibility	3.4.1	G AE															
			Evaluation																	
			SD-10 Operation and Maintenance																	
			Data																	
			Maintenance Instruction	3.4.3																
		02921a	SD-03 Product Data																	
			Surface Erosion Control Material	2.7	G AE															
			Chemical Treatment Material	1.4.3	G AE															
			Delivery	1.4.1																
			Topsoil	2.2																
			Seed Establishment Period	3.7	G AE															
			Maintenance Record	3.7.3.4																
			SD-04 Samples																	
			Delivered Topsoil	1.4.1.1	G AE															
			Soil Amendments	2.3	G AE															
			Mulch	2.4	G AE															
			SD-06 Test Reports																	
			Soil Test	3.1.3																
			SD-07 Certificates																	
			Seed	2.1																
			Topsoil	2.2																
			pH Adjuster	2.3.1																

# SUBMITTAL REGISTER

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Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

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(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		02921a	Fertilizer	2.3.2													
			Organic Material	2.3.4													
			Soil Conditioner	2.3.5													
			Mulch	2.4													
			Asphalt Adhesive	2.5													
		02930a	SD-03 Product Data														
			Chemical Treatment Material	1.4.3.2	G AE												
			Delivery	1.4.1													
			Plant Establishment Period	3.9													
			Maintenance Record	3.9.2.6													
			Application of Pesticide	3.7													
			SD-04 Samples														
			Delivered Topsoil	1.4.1.2	G AE												
			Soil Amendments	3.1.4.2	G AE												
			Mulch	2.4	G AE												
			SD-06 Test Reports														
			Soil Test	3.1.4.2													
			Percolation Test	3.1.4.1													
			SD-07 Certificates														
			Plant Material	2.1													
			Topsoil	2.2													
			pH Adjuster	2.3.1													
			Fertilizer	2.3.2													
			Organic Material	2.3.3													
			Soil Conditioner	2.3.4													
			Organic Mulch	2.4.1													

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G #  R A P H	C L A S S I F I C A T I O N  G O V E R N M E N T	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
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(a)	(b)	(c)	ITEM SUBMITTED (d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		02930a	Mycorrhizal Fungi Inoculum	2.10													
			Pesticide	2.12													
		03100	SD-02 Shop Drawings														
			Formwork	3.1.1	G AE												
			SD-03 Product Data														
			Design	1.3	G AE												
			Form Materials	2.1	G AE												
			Form Releasing Agents	2.1.6	G AE												
		03200	SD-02 Shop Drawings														
			Reinforcement	3.1	G AE												
		03300	SD-03 Product Data														
			Mixture Proportions	1.7	G AE												
			Dry Shake Finish	3.7.5	G AE												
			SD-06 Test Reports														
			Testing and Inspection for	3.10	G AE												
			Contractor Quality Control														
		03413a	SD-02 Shop Drawings														
			Architectural Concrete Sills		G AE												
			SD-03 Product Data														
			Calculations	1.4.5	G AE												
			Mix Design														
			Manufacturer's Qualifications														
			SD-06 Test Reports														
			Materials	2.1													
		04200a	SD-02 Shop Drawings														
			Masonry Work		G AE												

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N / R E V I E W E R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY		DATE OF ACTION	DATE RCD FRM APPR	MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
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(a)	(b)	(c)	ITEM SUBMITTED (d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		04200a	SD-03 Product Data														
			Clay or Shale Brick	2.2	G AE												
			Insulation	2.12	G AE												
			Cold Weather Installation	3.1.2	G AE												
			SD-04 Samples														
			Concrete Masonry Units (CMU)	2.4	G AE												
			Clay or Shale Brick	2.2													
			GAE														
			Precast Concrete Sills;		G AE												
			Anchors, Ties, and Bar	2.8	G AE												
			Positioners														
			Expansion-Joint Material		G AE												
			Joint Reinforcement	2.9	G AE												
			Insulation	2.12	G AE												
			Portable Panel		G AE												
			SD-06 Test Reports														
			Efflorescence Test	3.21.3	G AE												
			Field Testing of Mortar	3.21.1	G AE												
			Field Testing of Grout	3.21.2	G AE												
			Fire-rated CMU	2.4.3	G AE												
			Special Inspection		G												
			SD-07 Certificates														
			Clay or Shale Brick	2.2													
			Concrete Masonry Units (CMU)	2.4													
			Joint Reinforcement	2.9													
			Reinforcing Steel Bars and Rods	2.10													

CONTRACT NO.

## Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR: SCHEDULE DATES	CONTRACTOR ACTION		APPROVING AUTHORITY		
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CONTRACT NO.

SUBMITTAL FORM, Jan 96

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N  O V E R S I E W O W N E R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
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(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		07220a	SD-03 Product Data														
			Application of Insulation	3.7	G AE												
			Inspection	3.8													
			SD-07 Certificates														
			Insulation	2.2													
			Glass Roofing Felt	2.4													
			Organic Roofing Felt	2.5													
		07413a	SD-02 Shop Drawings														
			Siding	2.2	G AE												
			SD-04 Samples														
			Accessories	2.4	G AE												
			Siding	2.2	G AE												
			Fasteners	2.5	G AE												
			Insulation		G AE												
			Gaskets and Insulating Compounds	2.7													
			Sealant	2.6	G AE												
			Wall Liners		G AE												
			SD-07 Certificates														
			Siding	2.2													
			Installation	3.1													
			Accessories	2.4													
			Insulation														
		07416a	SD-02 Shop Drawings														
			Structural Standing Seam Metal Roof System		G AE												

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
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		07416a	SD-03 Product Data														
			Design Analysis		G AE												
			Qualifications														
			SD-04 Samples														
			Accessories	2.4													
			Roof Panels	2.2													
			Factory Color Finish	2.6	G AE												
			Fasteners	2.5													
			Insulation	2.7													
			Gaskets and Insulating Compounds	2.10													
			Sealant	2.9													
			Concealed Anchor Clips	2.3													
			Subpurlins														
			EPDM Rubber Boots	2.14													
			SD-06 Test Reports														
			Test Report for Uplift Resistance of the SSSMR														
			SD-07 Certificates														
			Structural Standing Seam Metal Roof System														
			Insulation	2.7													
		07510a	SD-07 Certificates														
			Bitumen	2.2													
			Felt	2.5													
			Cants	2.4													



# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION						CONTRACTOR											
Neval Thomas Elementary School - Submittal Register Issue																	
A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N / R E V I E W N O	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY		DATE OF ACTION	MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS	
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(a)	(b)	(c)	ITEM SUBMITTED (d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		07561	SD-02 Shop Drawings														
			Product Data														
			For each type														
			Samples for Verification														
			SD-07 Certificates														
			Installer Certificates: Signed by														
			manufacturers certifying that														
			installers comply with														
			requirements.														
			SD-10 Operation and Maintenance														
			Data														
			Maintenance Data: For roofing														
			system to include in maintenance														
			manuals.														
			SD-11 Closeout Submittals														
			Warranties: Draft of special														
			warranty specified in this Section														
			Inspection Report for Information:														
			Copy of roofing system														
			manufacturer's inspection report of														
			completed roofing membrane.														
		07600a	SD-02 Shop Drawings														
			Materials	2.1	G AE												
		07840a	SD-02 Shop Drawings														
			Firestopping Materials	2.1	G AE												
			SD-07 Certificates														

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N / C A R T H O W N R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
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		07840a	Firestopping Materials	2.1													
			Installer Qualifications	1.5													
			Inspection	3.3													
		07900a	SD-03 Product Data														
			Backing	2.1	G AE												
			Bond-Breaker	2.2	G AE												
			Sealant	2.4	G AE												
			SD-07 Certificates														
			Sealant	2.4													
		08110	SD-02 Shop Drawings														
			Doors	2.1	G AE												
			Doors	2.1	G AE												
			Frames	2.6	G AE												
			Frames	2.6	G AE												
			Accessories	2.4													
			Weatherstripping	2.8													
			SD-03 Product Data														
			Doors	2.1	G AE												
			Frames	2.6	G AE												
			Accessories	2.4													
			Weatherstripping	2.8													
		08120	SD-02 Shop Drawings														
			Doors and frames	2.1	G AE												
			SD-08 Manufacturer's Instructions														
			Doors and frames	2.1													
		08210	SD-02 Shop Drawings														

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N S I E C A R E I V O W N R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
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		08210	Doors	2.1	G AE												
			SD-03 Product Data														
			Doors	2.1	G AE												
			Accessories	2.2													
			Water-resistant sealer	2.3.6													
			warranty	1.4													
			Fire resistance rating	2.1.2	G AE												
			SD-04 Samples														
			Doors	2.1													
			Door finish colors	2.3.5.2	G AE												
			SD-06 Test Reports														
			Split resistance	2.4													
			Cycle-slam	2.4													
			Hinge loading resistance	2.4													
		08520a	SD-02 Shop Drawings														
			Aluminum Windows		G AE												
			Insect Screens	2.3													
			SD-03 Product Data														
			Aluminum Windows														
			SD-04 Samples														
			Aluminum Windows		G AE												
			SD-06 Test Reports														
			Aluminum Windows														
			SD-07 Certificates														
			Aluminum Windows														
		08710	SD-02 Shop Drawings														

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
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		08710	Hardware schedule	1.3	G AE												
			Keying system	2.3.6													
			SD-03 Product Data														
			Hardware items	2.3	G AE												
			SD-08 Manufacturer's Instructions														
			Installation	3.1													
			SD-10 Operation and Maintenance														
			Data														
			Hardware Schedule	1.3													
			SD-11 Closeout Submittals														
			Key bitting	1.4													
		08716	SD-02 Shop Drawings														
			Wiring Diagrams		G AE												
			SD-03 Product Data														
			Roughing-in diagrams		G AE												
			Certified performance reports														
			Installation instructions														
			Parts lists														
		08810a	SD-02 Shop Drawings														
			Installation	3.2	G AE												
			SD-03 Product Data														
			Insulating Glass	2.2	G AE												
			Glazing Accessories	2.6													
			SD-04 Samples														
			Insulating Glass	2.2	G AE												
			SD-07 Certificates														

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N / R E V I E W I N G	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR AUTH	REMARKS
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		08810a	Insulating Glass	2.2													
			Glazing Accessories	2.6													
		08900	SD-02 Shop Drawings														
			Glazed curtain wall system	1.5	G AE												
			SD-03 Product Data														
			Glazed curtain wall system	1.5													
			SD-05 Design Data														
			Calculations	1.3	G AE												
			SD-08 Manufacturer's Instructions														
			Glazed curtain wall system	1.5													
			Insulating glass														
		09100N	SD-02 Shop Drawings														
			Metal support systems	2.1	G AE												
			SD-05 Design Data														
			Calculations for non-load bearing stud wall (including exterior wall)		G AE												
		09250	SD-03 Product Data														
			Cementitious backer units	2.1.5													
			Glass Mat Water-Resistant														
			Gypsum Tile Backing Board														
			Water-Resistant Gypsum Backing Board	2.1.3													
			Glass Mat Covered or Reinforced														
			Gypsum Sheathing														
			Glass Mat Covered or Reinforced														
			Gypsum Sheathing Sealant														

# SUBMITTAL REGISTER

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TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

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		09250	Impact Resistant Gypsum Board	2.1.4													
			Accessories	2.1.10													
			SD-04 Samples														
			Predecorated gypsum board		G AE												
			SD-07 Certificates														
			Asbestos Free Materials	2.1													
		09310A	SD-03 Product Data														
			Tile	2.1	G AE												
			Setting-Bed	2.2													
			Mortar, Grout, and Adhesive	2.4													
			SD-04 Samples														
			Tile	2.1	G AE												
			Accessories														
			Marble Thresholds														
			SD-06 Test Reports														
			Testing														
			SD-07 Certificates														
			Tile	2.1													
			Mortar, Grout, and Adhesive	2.4													
		09510A	SD-02 Shop Drawings														
			Approved Detail Drawings	1.3	G AE												
			SD-03 Product Data														
			Acoustical Ceiling Systems														
			SD-04 Samples														
			Acoustical Units	2.1	G AE												
			SD-07 Certificates														

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

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											(g)					(h)	
(a)	(b)	(c)	ITEM SUBMITTED (d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		09510A	Acoustical Units	2.1													
		09640A	SD-02 Shop Drawings														
			Stage Flooring		G AE												
			SD-03 Product Data														
			Installation	3.2	G AE												
			SD-04 Samples														
			Strip Flooring	2.1	G AE												
		09650A	SD-03 Product Data														
			Resilient Flooring and		G AE												
			Accessories														
			SD-04 Samples														
			Flooring	3.2	G AE												
			SD-06 Test Reports														
			Moisture Test	3.3													
		09680A	SD-02 Shop Drawings														
			Installation	3.4	G AE												
			Molding	2.3													
			SD-03 Product Data														
			Carpet		G AE												
			Surface Preparation	3.1													
			Installation	3.4													
			Regulatory Requirements	1.3													
			SD-04 Samples														
			Carpet		G AE												
			Molding	2.3	G AE												
			SD-06 Test Reports														

# SUBMITTAL REGISTER

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TITLE AND LOCATION						CONTRACTOR											
Neval Thomas Elementary School - Submittal Register Issue																	
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		09680A	Moisture and Alkalinity Tests	3.2													
			SD-07 Certificates														
			Carpet														
			Regulatory Requirements	1.3													
			SD-10 Operation and Maintenance														
			Data														
			Carpet														
			Cleaning and Protection	3.5													
		09900	SD-02 Shop Drawings														
			Piping identification	3.10													
			stencil	3.10													
			SD-03 Product Data														
			Coating	2.1	G AE												
			Manufacturer's Technical Data	2.1													
			Sheets														
			Sealant														
			SD-04 Samples														
			Color	1.9	G AE												
			Textured Wall Coating System		G AE												
			Sample Textured Wall Coating		G AE												
			System Mock-Up														
			SD-07 Certificates														
			Applicator's qualifications	1.3													
			Qualification Testing	1.4.1.2													
			SD-08 Manufacturer's Instructions														
			Application instructions														



# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

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		09900	Mixing	3.6.2													
			Manufacturer's Material Safety	1.7.2													
			Data Sheets														
			SD-10 Operation and Maintenance														
			Data														
			Coatings:	2.1													
		10100A	SD-03 Product Data														
			Visual Display Boards		G AE												
			SD-04 Samples														
			Aluminum	2.2.3	G AE												
			Porcelain Enamel	2.2.1	G AE												
			Materials	2.2	G AE												
			07 Certificates														
			Visual Display Boards														
		10160A	SD-02 Shop Drawings														
			Toilet Partition System		G AE												
			SD-03 Product Data														
			Toilet Partition System		G AE												
			SD-04 Samples														
			Toilet Partition System		G AE												
		10191N	SD-02 Shop Drawings														
			Cubicle track layout	1.3													
			SD-08 Manufacturer's Instructions														
			installation	3.1													
			SD-10 Operation and Maintenance														
			Data														

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

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		10191N	Cubicle track system	2.1	G AE												
		10201N	SD-02 Shop Drawings														
			Wall louvers	2.2	G AE												
			SD-04 Samples														
			Wall louvers	2.2	G AE												
		10350	SD-03 Product Data														
			flagpole														
		10430A	SD-02 Shop Drawings														
			Approved Detail Drawings		G AE												
			SD-03 Product Data														
			Installation														
			Exterior Signs		G AE												
			Wind Load Requirements	1.3													
			SD-04 Samples														
			Exterior Signs		G AE												
		10440A	SD-02 Shop Drawings														
			Detail Drawings	3.1	G AE												
			SD-03 Product Data														
			Installation	3.1													
			SD-04 Samples														
			Interior Signage	1.3	G AE												
			SD-10 Operation and Maintenance														
			Data														
			Protection and Cleaning	3.1.2													
		10650A	SD-02 Shop Drawings														
			Operable Partitions	2.2	G AE												

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N / R E V I E W I N G	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY		DATE OF ACTION	DATE RCD FRM APPR	MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
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		10650A	SD-03 Product Data														
			Operable Partitions	2.2	G AE												
			SD-04 Samples														
			Operable Partitions	2.2	G AE												
			SD-07 Certificates														
			Materials	2.1													
			Operable Partitions	2.2													
			SD-10 Operation and Maintenance														
			Data														
			Operable Partitions	2.2													
		10675N	SD-01 Preconstruction Submittals														
			Shelving Units	2.1													
			SD-03 Product Data														
			Shelving Units	2.1	G AE												
			Accessories	2.2	G AE												
			Installation instructions	3.2	G AE												
			SD-04 Samples														
			Finish	2.4	G AE												
			SD-06 Test Reports														
			Shelving Units	2.1													
			Finish	2.4													
		10800A	SD-03 Product Data														
			Finishes	2.1.2													
			Accessory Items	2.2													
			SD-04 Samples														
			Finishes	2.1.2													

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION						CONTRACTOR											
Neval Thomas Elementary School - Submittal Register Issue																	
A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N / R E V I E W N O	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY		DATE OF ACTION	MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS	
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		10800A	Accessory Items	2.2													
			SD-10 Operation and Maintenance Data														
			Electric Hand Dryer	2.2.12													
		10900	SD-03 Product Data														
			Television, VCR and Projector Mount		G AE												
		11400A	SD-02 Shop Drawings														
			Food Service Equipment Installation	2.1.6	G AE												
			SD-03 Product Data	3.1	G AE												
			Food Service Equipment	2.1.6	G AE												
			SD-06 Test Reports														
			Testing	3.2													
			SD-10 Operation and Maintenance Data														
			Food Service Equipment	2.1.6													
		11490	SD-02 Shop Drawings														
			Shop Drawings		G AE												
			SD-03 Product Data														
			Manufacturer's Data		G AE												
			SD-10 Operation and Maintenance Data														
			Gymnasium Equipment														
		12484	SD-04 Samples														
			Floor Mats	2.1	G AE												

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G # R A P H	C L A S S I F I C A T I O N / R E V I E W E R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
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		12490A	SD-02 Shop Drawings														
			Approved Detail Drawings	3.1	G AE												
			SD-03 Product Data														
			Window Treatments	3.1													
			Hardware	1.2													
			SD-04 Samples														
			Window Treatments	3.1	G AE												
		12491N	SD-04 Samples														
			Drapery fabric	2.1.1.1	G AE												
			SD-06 Test Reports														
			Flame resistance	2.1.1.3													
			SD-08 Manufacturer's Instructions														
			Drapery hardware	2.1.4													
			fabrication	2.2.1													
			SD-10 Operation and Maintenance														
			Data														
			Drapery system	1.3													
		12492	SD-01 Preconstruction Submittals														
			Product Data		G AE												
			Color Samples		G AE												
			Installation and Maintenance														
		13100A	SD-02 Shop Drawings														
			Drawings		G AE												
			SD-07 Certificates														
			Materials	2.1													
		13280A	SD-03 Product Data														

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION						CONTRACTOR											
Neval Thomas Elementary School - Submittal Register Issue																	
A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N  S I F I E C A R E I V O W N R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY			MAILED TO CONTR/		
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		13280A	Respiratory Protection Program	1.12	G AR												
			Cleanup and Disposal	3.11	G AR												
			Detailed Drawings		G AR												
			Materials and Equipment		G												
			Qualifications	1.5	G AR												
			Training Program	1.11	G AR												
			Medical Requirements	1.10	G AR												
			Encapsulants	2.1	G AR												
			SD-06 Test Reports														
			Exposure Assessment and Air	3.9	G AR												
			Monitoring														
			Local Exhaust Ventilation	1.20	G AR												
			Licenses, Permits and	1.14	G AR												
			Notifications														
			SD-07 Certificates														
			Vacuum, Filtration and Ventilation		G AR												
			Equipment														
		13281A	SD-03 Product Data														
			Qualifications	1.5	G AR												
			SD-06 Test Reports														
			Licences, Permits, and	1.11	G AR												
			Notifications														
			Accident Prevention Plan (APP)	1.7	G AR												
			Sampling and Analysis	1.13	G AR												
		13282N	SD-06 Test Reports														
			Sampling results	1.8	G AR												

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION						CONTRACTOR											
Neval Thomas Elementary School - Submittal Register Issue																	
A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N  O V E R S I E W I N G	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS	
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		13282N	Assessment Data Report	1.9	G AR												
			SD-07 Certificates														
			Qualifications of CP	1.5	G AR												
			Testing laboratory	1.6	G AR												
			Vacuum filters	1.11.4	G AR												
			Qualifications of workers and supervisors	1.7.1	G AR												
			Third party consultant		G AR												
			Material Containing Lead Removal Plan	1.7	G AR												
			Rental equipment notification	1.11.3	G AR												
			Respiratory protection program	1.10.4	G AR												
			Hazard communication program	1.10.5	G AR												
			disposal facility	3.2.5	G AR												
			Hazardous waste management plan	1.10.6	G AR												
			Assessment data report	1.9	G AR												
			SD-08 Manufacturer's Instructions														
			Chemicals	2.1	G AR												
			Material safety data sheets	2.1	G AR												
			SD-11 Closeout Submittals														
			manifest	3.2.5	G AR												
			medical examinations	1.10.1	G AR												
			training certification	1.10.3.1	G AR												
		13283N	SD-03 Product Data														
			Vacuum filters	1.12.4	G AR												

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N  S I F I E R I E S I V E S O W N E R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY				MAILED TO CONTR/	REMARKS		
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		13283N	Respirators	1.12.1	G AR														
			SD-06 Test Reports																
			Sampling results	1.9	G AR														
			Assessment data report	1.10	G AR														
			SD-07 Certificates																
			Qualifications of CP	1.5	G AR														
			Testing laboratory	1.7	G AR														
			Third party consultant	1.6	G AR														
			Lead-Containing Paint		G AR														
			Demolition Plan																
			Rental equipment notification	1.12.3	G AR														
			Respiratory protection program	1.11.4	G AR														
			Hazard communication program	1.11.5	G AR														
			disposal facility	3.2.5	G AR														
			Hazardous waste management	1.11.6	G AR														
			plan																
			Vacuum filters	1.12.4	G AR														
			SD-08 Manufacturer's Instructions																
			Chemicals	2.1	G AR														
			Materials	2.2	G AR														
			Material safety data sheets	2.1	G AR														
			SD-11 Closeout Submittals																
			manifest	3.2.5	G AR														
			medical examinations	1.11.1	G AR														
			training certification	1.11.3.1	G AR														
		13284N	SD-07 Certificates																



# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G #  R A P H	C L A S S I F I C A T I O N  O V E R S I E W I N G	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
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		13284N	Training certification	1.7.1	G AR												
			Qualifications of CIH	1.7.2	G AR												
			PCB removal work plan	1.7.3	G AR												
			PCB disposal plan	1.7.4	G AR												
			Notification	1.7.5	G AR												
			Transporter certification	3.8	G AR												
			Certification of Decontamination	3.5.4	G AR												
			Post cleanup sampling	3.5.5	G AR												
			Certificate of disposal	3.8.1	G AR												
		13286N	SD-07 Certificates														
			Qualifications of CIH	1.8.1	G AR												
			Training Certification	1.8.1	G AR												
			PCB and Lamp Removal Work Plan		G AR												
			PCB and Lamp Disposal Plan		G AR												
			SD-11 Closeout Submittals														
			Transporter certification	3.5.2	G AR												
			Certification of Decontamination	3.2.4													
			Certificate of Disposal and/or recycling	3.5.2.1													
			DD Form 1348-1														
		13851A	SD-02 Shop Drawings														
			Fire Alarm Reporting System	1.4.1	G AE												
			SD-03 Product Data														
			Storage Batteries	2.2	G AE												
			Voltage Drop		G AE												

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G #  R A P H	C L A S S I F I C A T I O N / R E V I E W I N G	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS	
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		13851A	Special Tools and Spare Parts	2.9.4	G AE													
			Technical Data and Computer	1.5	G AE													
			Software															
			Training	3.6														
			Testing	3.5	G AR													
			SD-06 Test Reports															
			Testing	3.5														
			SD-07 Certificates															
			Equipment															
			Qualifications	1.3.7														
			SD-10 Operation and Maintenance															
			Data															
			Technical Data and Computer	1.5														
			Software															
		13930A	SD-02 Shop Drawings															
			Sprinkler System Shop Drawings		G AE													
			As-Built Shop Drawings															
			SD-03 Product Data															
			Fire Protection Related	3.1	G AE													
			Submittals															
			Components and Equipment		G AE													
			Data															
			Hydraulic Calculations	1.7	G AE													
			Spare Parts															
			Preliminary Tests Procedures		G AE													

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N  S I F I C A R T E R I O R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/	APPROVING AUTHORITY			MAILED TO CONTR/	REMARKS	
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		13930A	Final Acceptance Test Procedures		G AE												
			On-site Training Schedule														
			Preliminary Tests	3.10													
			Final Acceptance Test														
			Fire Protection Specialist														
			Qualifications														
			Sprinkler System Installer	1.9													
			Qualifications														
			SD-06 Test Reports														
			Preliminary Tests Report														
			Final Acceptance Test Report														
			SD-07 Certificates														
			Fire Protection Specialist														
			Inspection														
			SD-10 Operation and Maintenance														
			Data														
			Wet Pipe Sprinkler System														
		14240A	SD-02 Shop Drawings														
			Elevator System		G AE												
			SD-03 Product Data														
			Training Data														
			Elevator System														
			Framed Instructions	3.6													
			Test Procedures		G												
			SD-04 Samples														

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N / R E V I E W N O	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
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		14240A	Finishes														
			SD-06 Test Reports														
			Testing	3.5													
			SD-07 Certificates														
			Qualification Certificates														
			SD-10 Operation and Maintenance														
			Data														
			Elevator System		G												
		15070	SD-02 Shop Drawings														
			Inertia bases	2.7													
			Machinery bases	2.6													
			Roof curb mounted base														
			Rails	2.6													
			Saddles	2.6	G AE												
			SD-03 Product Data														
			Isolators	2.3													
			Flexible connectors	2.9													
			Flexible duct connectors	2.10													
			Pipe guides	2.11													
			Vertical stops	3.1.3													
			Inertia bases	2.7													
			Machinery bases	2.6													
			Machinery foundations and	3.1.11													
			subbases														
			Roof curb mounted base														
			Rails	2.6													

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G # R A P H	C L A S S I F I C A T I O N / R E V I E W E R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR AUTH	REMARKS
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		15070	Saddles	2.6													
			Machinery manufacturer's sound data	1.4.2	G AE												
			SD-05 Design Data														
			Inertia bases	2.7													
			Machinery bases	2.6													
			Roof curb mounted base														
			Rails	2.6													
			Saddles	2.6													
			machinery	1.4.3													
			machinery over 300 pounds														
			SD-06 Test Reports														
			Equipment vibration tests	3.2.3.1													
			Equipment sound level tests	3.2.3.2													
			Protected spring isolators	2.4													
			SD-08 Manufacturer's Instructions														
			Vibration and noise isolation components	3.1.1													
		15181	SD-02 Shop Drawings														
			Piping System	2.4	G AE												
			SD-03 Product Data														
			Piping System	2.4													
			Water Treatment Systems	2.12													
			Spare Parts														
			Qualifications	1.3													
			Field Tests	3.3													

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G # R A P H	C L A S S I F I C A T I O N R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
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		15181	Demonstrations	3.4													
			Verification of Dimensions	1.6.1													
			SD-06 Test Reports														
			Field Tests	3.3													
			SD-07 Certificates														
			Service Organization	2.1													
			SD-10 Operation and Maintenance														
			Data														
			Operation Manuals														
			Maintenance Manuals	3.4													
			Water Treatment Systems	2.12													
		15182	SD-03 Product Data														
			Qualifications	1.3													
			Refrigerant Piping Tests	3.3													
			Service Organization	2.1													
		15183	SD-02 Shop Drawings														
			Piping System	2.4													
			SD-03 Product Data														
			Piping System	2.4													
			Glycol/Water Make-up System	2.13													
			Spare Parts														
			Qualifications	1.3													
			Field Tests	3.3													
			Demonstrations	3.4													
			Verification of Dimensions	1.6.1													
			SD-06 Test Reports														

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N / R E V I E W I N G	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
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		15183	Field Tests	3.3													
			One-Year Inspection	3.5													
			SD-07 Certificates														
			Service Organization	2.1													
			SD-10 Operation and Maintenance Data														
			Operation Manuals														
			Maintenance Manuals	3.4													
			Glycol/Water Make-up System	2.13													
		15190	SD-02 Shop Drawings														
			Gas Piping System	3.2	G AE												
			SD-06 Test Reports														
			Testing	3.15													
			Pressure Tests	3.15.1													
			Test With Gas	3.15.2													
		15261	SD-02 Shop Drawings														
			Schematic diagrams	1.5.1	G AE												
			Interconnecting diagrams	1.5.2	G AE												
			Installation drawings	1.5.3	G AE												
			SD-03 Product Data														
			Variable frequency drives	2.1	G AE												
			Wires and cables	2.3													
			Equipment schedule	1.5.4													
			SD-06 Test Reports														
			VFD Test	3.2.1													
			Performance Verification Tests	3.2.2													

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION						CONTRACTOR														
Neval Thomas Elementary School - Submittal Register Issue																				
A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N / R E V I E W N O	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY		DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	A C T I O N  C O D E	DATE OF ACTION	MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS	
						SUBMIT (g)	BY (h)	MATERIAL NEEDED BY (i)	A C T I O N  C O D E (j)	DATE OF ACTION (k)		DATE FWD TO APPR AUTH/ (l)	DATE FWD TO OTHER REVIEWER (m)							DATE RCD FROM OTH REVIEWER (n)
		15261	Endurance Test	3.2.3																
			SD-08 Manufacturer's Instructions																	
			Installation instructions	1.5.5																
			SD-09 Manufacturer's Field																	
			Reports																	
			VFD Factory Test Plan	2.5.1																
			Factory test results	1.5.6																
			SD-10 Operation and Maintenance																	
			Data																	
			Variable frequency drives	2.1																
		15400	SD-02 Shop Drawings																	
			Plumbing System	3.7.1	G AE															
			SD-03 Product Data																	
			Plumbing Fixture Schedule	3.8	G AE															
			Plumbing System	3.7.1	G AE															
			SD-06 Test Reports																	
			Tests, Flushing and Disinfection	3.7																
			Backflow Prevention Assembly																	
			Tests																	
			SD-07 Certificates																	
			Materials and Equipment																	
			Bolts	2.1.1																
			SD-10 Operation and Maintenance																	
			Data																	
			Plumbing System	3.7.1																
		15556	SD-02 Shop Drawings																	



# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

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A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G #  R A P H	C L A S S I F I C A T I O N  S I F I C A R E V I O W N R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
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		15556	Heating System	2.12	G AE												
			SD-03 Product Data														
			Piping System														
			Water Treatment Systems														
			Spare Parts														
			Qualifications														
			Field Tests														
			Demonstrations														
			Verification of Dimensions	1.6.1													
			Framed Instructions	3.17													
			SD-06 Test Reports														
			Testing and Cleaning	3.13													
			Water Treatment Testing	3.13.4													
			SD-10 Operation and Maintenance														
			Data														
			Operation Manuals														
			Maintenance Manuals														
			Water Treatment Systems														
		15569	SD-02 Shop Drawings														
			Breeching and flue stack		G AE												
			SD-03 Product Data														
			Manufacturer's Catalog Data														
			Spare Parts Data														
			Heating System Tests														
			Welding	1.3.7													
			Qualification														

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G #  R A P H	C L A S S I F I C A T I O N / R E V I E W I N G	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
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		15569	Field Instructions	3.7													
			Field Tests														
			SD-06 Test Reports														
			Field Tests														
			SD-07 Certificates														
			Service Organization	1.3.1													
			Bolts														
			Continuous Emissions														
			Monitoring														
			SD-10 Operation and Maintenance														
			Data														
			Boilers	3.5.1													
			Maintenance Manuals														
		15645	SD-03 Product Data														
			Cooling Tower	2.5													
			Spare Parts														
			Posted Instructions	3.4													
			Performance Tests	3.3													
			Demonstrations	3.4													
			Verification of Dimensions	1.5.1													
			SD-06 Test Reports														
			Performance Tests	3.3													
			SD-07 Certificates														
			Service Organization	2.1													
			SD-10 Operation and Maintenance														
			Data														

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G # R A P H	C L A S S I F I C A T I O N S I E C A R E V O W N R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR AUTH	REMARKS
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		15645	Operation Manuals														
			Maintenance Manuals	3.4													
		15700	SD-02 Shop Drawings														
			Drawings		G AE												
			SD-03 Product Data														
			Equipment														
			Spare Parts Data														
			Posted Instructions	3.5													
			Verification of Dimensions	1.5.1													
			System Performance Tests	3.4													
			Demonstrations	3.5													
			SD-06 Test Reports														
			Refrigerant Tests, Charging, and Start-Up	3.3	G AE												
			System Performance Tests	3.4	G AE												
			SD-07 Certificates														
			Equipment														
			Service Organization	2.1													
			SD-10 Operation and Maintenance														
			Data														
			Operation Manuals														
			Maintenance Manuals	3.5													
		15701	SD-02 Shop Drawings														
			Drawings		G AE												
			SD-03 Product Data														
			Equipment														

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

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A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G # R A P H	C L A S S I F I C A T I O N R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
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		15701	Spare Parts Data														
			Posted Instructions	3.5													
			Verification of Dimensions	1.5.1													
			System Performance Tests	3.4													
			Demonstrations	3.5													
			SD-06 Test Reports														
			Refrigerant Tests, Charging, and Start-Up	3.3	G AE												
			System Performance Tests	3.4	G AE												
			SD-07 Certificates														
			Equipment														
			Service Organization	2.1													
			SD-10 Operation and Maintenance Data														
			Operation Manuals														
			Maintenance Manuals	3.5													
		15768	SD-02 Shop Drawings														
			Heater installation drawing	3.1	G AE												
			SD-03 Product Data														
			Electric unit and wall heaters	2.1													
			Thermostat	2.1.6													
			Unit thermostat														
			SD-10 Operation and Maintenance Data														
			Electric unit and wall heaters	2.1													
		15895	SD-02 Shop Drawings														

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

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		15895	Drawings														
			Installation	3.1	G AE												
			SD-03 Product Data														
			Components and Equipment	2.1													
			Test Procedures														
			Welding Procedures														
			System Diagrams														
			Similar Services														
			Welding Joints														
			Testing, Adjusting and Balancing	3.4													
			Field Training	3.6													
			SD-06 Test Reports														
			Performance Tests	3.5													
			SD-07 Certificates														
			Bolts														
			SD-10 Operation and Maintenance														
			Data														
			Operating and Maintenance	3.6													
			Instructions														
		15951	SD-02 Shop Drawings														
			Drawings	1.3.4													
			SD-03 Product Data														
			BACnet internetwork	2.8													
			Service Organizations	2.1													
			Equipment Compliance Booklet	1.6													
			Commissioning Procedures	3.19													

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION						CONTRACTOR											
Neval Thomas Elementary School - Submittal Register Issue																	
A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N / R E V I E W I N G	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY		DATE OF ACTION	MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS	
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		15951	Performance Verification Test Procedures	1.6													
			Training Course Requirements	3.21.1													
			SD-06 Test Reports														
			Commissioning Report	3.20.3													
			Performance Verification Test	3.20.3													
			SD-10 Operation and Maintenance Data														
			Operation Manual	1.5													
			Maintenance and Repair Manual	1.6													
		15990	SD-06 Test Reports														
			Certified DALT report	1.7.5.1	G AE												
			Certified TAB report for Season 1	1.7.5.2	G AE												
			Certified TAB report for Season 2	1.7.5.2	G AE												
			SD-07 Certificates														
			Independent TAB agency personnel qualifications	1.7.2.1	G AE												
			Pre-field DALT preliminary notification	1.7.2.3													
			Pre-field TAB engineering report	1.7.2.4													
			Advanced notice for DALT field work	1.6													
			Advanced notice for Season 1 TAB field work	1.6													
			Pre-TAB check out list for Season 1	1.6													

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

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# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION						CONTRACTOR											
Neval Thomas Elementary School - Submittal Register Issue																	
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(a)	(b)	(c)	ITEM SUBMITTED (d)	(e)	(f)				(j)								
		16403	Motor Control Center	2.5													
		16415	SD-02 Shop Drawings														
			Interior Electrical Equipment														
			As-Built Drawings		G AE												
			SD-03 Product Data														
			Fault Current and Protective		G AE												
			Device Coordination Study														
			Manufacturer's Catalog		G AE												
			Material, Equipment, and Fixture		G AE												
			Lists														
			SD-06 Test Reports														
			Field Test Plan														
			Field Test Reports														
			SD-07 Certificates														
			Materials and Equipment		G AE												
		16528	SD-02 Shop Drawings														
			Lighting System		G AE												
		16530	SD-02 Shop Drawings														
			Wiring Diagrams														
			Coordination Drawings														
			SD-03 Product Data														
			Electrical Components, Devices	1.5													
			and Accessories														
			Functional System Description	2.3													
			Control Module	2.4													
			Automatic Time Adjustment	2.4													



# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G # R A P H	C L A S S I F I C A T I O N R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR AUTH	REMARKS
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		16530	Astronomic Control	2.4													
			Remote Communication	2.4													
			Capability														
			Conductors and Cables	2.7													
			Power Distribution Components	2.5													
			Modular Relay Panel	2.5.1													
			Single-Pole Relays	2.5.1													
			Electrically Operated.	2.5.2													
			Molded-Case Circuit Breaker														
			Panel														
			Switches	2.6													
			Wiring Installation	3.1													
			Occupancy Sensors	2.8													
			Software and Firmware														
			Operational Documentation														
			Software	1.7													
		16535	SD-03 Product Data														
			Fluorescent dimmer	2.3													
			Multichannel, remote-controlled dimmers	2.5													
			Dimmers: Solid state, with silicon-controlled rectifiers	2.5													
			Master station	2.3													
			Remote-control stations	2.4													
			Master Digital Network Control Station	2.5													

# SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Neval Thomas Elementary School - Submittal Register Issue

CONTRACTOR

A C T I V I T Y  N O	T R A N S M I T T A L  N O	S P E C  S E C T	DESCRIPTION	P A R A G R A P H	C L A S S I F I C A T I O N R	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION		DATE FWD TO APPR AUTH/  DATE RCD FROM CONTR	APPROVING AUTHORITY				MAILED TO CONTR/  DATE RCD FRM APPR	REMARKS
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		16535	Submaster Digital Network	2.5													
			Control Stations														
			Digital control network	2.5													
			Microprocessor-based,	2.5													
			solid-state controls														
			Dimmer cabinets	2.5													
			Manual switches and plates	2.6													
			SD-11 Closeout Submittals														
			Warranties	1.7													
		16620	SD-03 Product Data														
			Security Panel														
			Motion Detectors	2.4													
			Audio/Visual Remote Entry														
			System														
		16730	SD-03 Product Data														
			Clock System	2.3	G AE												
		16770	SD-03 Product Data														
			Wiring		G AE												
			Transient Protection														
			Global Switching System														
			Central Switching Exchange														
			Intercom and Public Address														
			System														
			Program Distribution														
			Amplification and Control														
			Equipment														



## SECTION 15951

## BACNET INTERNETWORKED CONTROL SYSTEM

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 500-D (1997) Laboratory Methods of Testing  
Dampers for Rating

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 269 (2000) Seamless and Welded Austenitic  
Stainless Steel Tubing for General Service

ASTM B 88 (1999) Seamless Copper Water Tube

ASTM D 1693 (2000) Environmental Stress-Cracking of  
Ethylene Plastics

ASTM D 635 (1998) Rate of Burning and/or Extent and  
Time of Burning of Self-Supporting  
Plastics in a Horizontal Position

AMERICAN SOCIETY OF HEATING, REFRIGERATION AND AIR CONDITIONING  
ENGINEERS (ASHRAE)

ASHRAE 135-1995 (1995, including Addendums A through E)  
BACnet-A Data Communication Protocol for  
Building Automation and Control Networks

## ASME INTERNATIONAL (ASME)

ASME B16.34 (1997) Valves - Flanged, Threaded, and  
Welding End

ASME B40.1 (1991) Gauges - Pressure Indicating Dial  
Type - Elastic Element

ASME BPVC SEC VIII D1 (1998) Boiler and Pressure Vessel Code;  
Section VIII, Pressure Vessels Division 1  
- Basic Coverage

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits
ISA - THE INSTRUMENTATION, SYSTEMS AND AUTOMATION SOCIETY (ISA)	
ISA S7.0.01	(1996) Quality Standard for Instrument Air
NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)	
NEMA 250	(1997) Enclosures for Electrical Equipment (1000 Volts Maximum)
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 70	(1999) National Electrical Code
NFPA 90A	(1999) Installation of Air Conditioning and Ventilating Systems
U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)	
47 CFR 15	Radio Frequency Devices
UNDERWRITERS LABORATORIES (UL)	
UL 268A	(1998) Smoke Detectors for Duct Application
UL 508	(1999) Industrial Control Equipment
UL 555S	(1999) Safety for Smoke Dampers
UL 916	(1998) Energy Management Equipment
UL 94	(1996; Rev thru Jul 1998) Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

#### Drawings

Drawings on A1 34 by 22 inch sheets in the form and arrangement shown. The drawings shall use the same abbreviations, symbols, nomenclature and device identifiers shown. Each control-system element on a drawing shall have a unique identifier as shown. All

HVAC control system drawings shall be delivered together as a complete submittal. Drawings shall be submitted for each HVAC system.

- a. HVAC control system drawings shall include the following:

Sheet One: Drawing index, HVAC control system legend.

Sheet Two: Valve schedule, damper schedule.

Sheet Three: Compressed air station schematic.

Sheet Four: HVAC control system schematic and equipment schedule.

Sheet Five: HVAC control system sequence of operation and ladder diagram.

Sheet Six: HVAC control panel arrangement, control panel cross-section, and control panel inner door layout.

Sheet Seven: HVAC control panel back-panel layout.

Sheet Eight: Control loop wiring diagrams.

Sheet Nine: Motor starter and relay wiring diagram.

Note: Repeat sheets four through nine for each AHU system.

- b. An HVAC control system drawing index showing the name and number of the building, State or other similar designation. The drawing index shall list all HVAC control system drawings, including the drawing number, sheet number, drawing title, and computer filename when used.

- c. An HVAC control system legend showing generic symbols and the name of devices shown on the HVAC control system drawings.

- d. A valve schedule showing each valve's unique identifier, size, flow coefficient (Cv), pressure drop at specified flow rate, spring range, positive positioner range, actuator size, close-off pressure data, dimensions, and access and clearance requirements data.

- e. A damper schedule showing each damper and actuator's identifier, nominal and actual sizes, orientation of axis and frame, direction of blade rotation, spring ranges, operation rate, positive positioner ranges, locations of actuators and damper end switches, arrangement of sections in multi-section dampers, and methods of connecting dampers, actuators, and linkages. The damper schedule shall include the maximum leakage rate at the operating static-pressure differential. The damper schedule shall contain actuator selection data supported by calculations of the torque required to move and seal the dampers, access and clearance

requirements.

f. An HVAC control system equipment schedule showing the control loop, device unique identifier, device function, set point, input range, and additional important parameters (i.e. output range).

g. An HVAC control system sequence of operation.

h. An HVAC control system ladder diagram showing all relays, contacts, pilot lights, switches, fuses and starters connected to the control system.

i. HVAC control panel arrangement drawings showing both side and front views of the panel. The drawing shall show panel and mounting dimensions.

j. HVAC control panel cross-section drawings showing mounting rails and standoffs for devices.

k. HVAC control panel inner door layout drawings showing both front and rear views of the inner door. The drawings shall show device locations, labels, nameplate legends, and fabrication details.

l. HVAC control panel back-panel layout drawings showing device locations, labels, nameplate legends, terminal block layout, fabrication details, and enclosure operating temperature-rise calculations.

m. HVAC control system wiring diagrams showing functional wiring diagrams of the interconnection of conductors and cables to HVAC control panel terminal blocks and to the identified terminals of devices, starters and package equipment. The wiring diagrams shall show all necessary jumpers and ground connections. The wiring diagrams shall show the labels of all conductors. Sources of power required for HVAC control systems and for packaged-equipment control systems shall be identified back to the panel-board circuit breaker number, HVAC system control panel, magnetic starter, or packaged equipment control circuit. Each power supply and transformer not integral to a controller, starter, or packaged equipment shall be shown. The connected volt-ampere load and the power supply volt-ampere rating shall be shown.

#### SD-03 Product Data

BACnet internetwork system (BICS)  
Service Organizations

Six copies of a list of service organizations qualified to service the HVAC control system. The list shall include the service organization name, address, technical point of contact and telephone number, and contractual point of contact and telephone

number.

#### Equipment Compliance Booklet

An HVAC control system equipment compliance booklet (ECB) in indexed booklet form with numbered tabs separating the information on each device. It shall consist of, but not be limited to, data sheets and catalog cuts which document compliance of all devices and components with the specifications. The ECB shall be indexed in alphabetical order by the unique identifiers. Devices and components which do not have unique identifiers shall follow the devices and components with unique identifiers and shall be indexed in alphabetical order according to their functional name. The ECB shall include a bill of materials for each HVAC control system. The bill of materials shall function as the table of contents for the ECB and shall include the device's unique identifier, device function, manufacturer, model/part/catalog number used for ordering, and tab number where the device information is located in the ECB.

#### Commissioning Procedures

a. Six copies of the HVAC control system commissioning procedures, in indexed booklet form, 60 days prior to the scheduled start of commissioning. Commissioning procedures shall be provided for each HVAC control system, and for each type of terminal-unit control system. The commissioning procedures shall reflect the format and language of this specification, and refer to devices by their unique identifiers as shown. The commissioning procedures shall be specific for each HVAC system, and shall give detailed step-by-step procedures for commissioning of the system.

b. Commissioning procedures documenting detailed, product-specific set-up procedures, configuration procedures, adjustment procedures, and calibration procedures for each device. Where the detailed product-specific commissioning procedures are included in manufacturer supplied manuals, reference may be made in the HVAC control system commissioning procedures to the manuals.

c. Commissioning procedures documenting controller configuration checksheets for each controller listing all configuration parameters, dip switch and jumper settings, and initial recommended P, I and D values. The configuration parameters shall be listed in the order in which they appear during the configuration process. Each configuration parameter shall be noted as being: set per specs with no field adjustment required, set per specs but field adjustable, or not applicable.

d. Commissioning procedures showing a time clock configuration checksheet listing all parameters, and switch settings. The parameters shall be listed in the order which they appear during the setup process.



e. An HVAC control system commissioning procedures equipment list that lists the equipment to be used to accomplish commissioning. The list shall include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration.

#### Performance Verification Test Procedures

Six copies of the HVAC control system performance verification test procedures, in indexed booklet form, 60 days before the Contractor's scheduled test dates. The performance verification test procedures shall refer to the devices by their unique identifiers as shown, shall explain, step-by-step, the actions and expected results that will demonstrate that the HVAC control system performs in accordance with the sequences of operation. An HVAC control system performance verification test equipment list shall be included that lists the equipment to be used during performance verification testing. The list shall include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration.

#### Training Course Requirements

Six copies of HVAC control system training course material 30 days prior to the scheduled start of the training course. The training course material shall include the operation manual, maintenance and repair manual, and paper copies of overheads used in the course. An HVAC control system training course, in outline form, with a proposed time schedule. Approval of the planned training schedule shall be obtained from the Government at least 60 days prior to the start of the training.

#### SD-06 Test Reports

##### Commissioning Report

Six copies of the HVAC control system commissioning report, in indexed booklet form, within 30 days after completion of the system commissioning. The commissioning report shall include data collected during the HVAC control system commissioning and shall follow the format of the commissioning procedures. The commissioning report shall include all controller and time clock checksheets with final values listed for all parameters, set points, P, I, D setting constants, calibration data for all devices, and results of adjustments.

##### Performance Verification Test

Six copies of the HVAC control system performance verification test report, in indexed booklet form, within 30 days after completion of the test. The HVAC control system performance verification test report shall include data collected during the HVAC control system performance verification test. The original copies of data gathered during the performance verification test

shall be turned over to the Government after Government approval of the test results.

#### SD-10 Operation and Maintenance Data

Operation Manual  
Maintenance and Repair Manual

Six copies of the HVAC control system operation manual and HVAC control system maintenance and repair manual for each HVAC control system 30 days before the date scheduled for the training course.

### 1.3 GENERAL REQUIREMENTS

The Control System shall be an on-line network of distributed, communicating microprocessor based stand-alone controllers, including PC based operator work station interfaces and programming software applications, field sensors, control devices, enclosures and interconnecting conduit and wire.

The networked components of the system shall make up a BACnet Internetwork including at least a high speed and/or other LAN's interconnecting BACnet devices. Those devices on the BACnet internetwork shall communicate exclusively utilizing the BACnet protocol on BACnet LAN types.

Actuation of control devices shall be electronic. Spring return fail-safe actuation shall be provided.

The BACnet Internetwork System shall be based on Manufacturer's standard integrated hardware and software product offering, which has been installed and fully operational in similar service for not less than 2 years.

#### 1.3.1 Basic System Architecture

The system components shall include but not be limited to the following:

1. PC Operating System Software
2. Control System Application Software
3. 3rd Party Software
4. Operator Work Station (B-OWS)
5. Remote Operator Work Station (B-ROWS) (if required)
6. Portable Operator Work Station (B-POWS)
7. Building Controllers (B-BC)
8. Advanced Application Controllers (B-AAC)
9. Application Specific Controllers (B-ASC)

10. Enclosures
11. Field Sensors
12. Controlled Devices
13. Interconnecting Wire and Cabling
14. Service Tools
15. Network LAN's and Communication Protocols
16. Proper interfaces for Hardwire Connection to VSD; chillers and lighting control
17. Proper serial interface to other system listed below:

Field Sensors and Control Devices shall connect to stand-alone B-AAC and B-ASC as required to achieve the point monitoring and control sequences specified. In general all mechanical systems, except those so noted, are to be digitally controlled by B-AAC and B-ASC, monitored by B-OWS or B-BC and are to be electronically actuated. Each mechanical system shall have a dedicated B-AAC or B-ASC that shall be connected to all field sensors and control devices for that system. Sensors and Control devices shall be UL listed.

#### 1.3.2 Work Furnished but not Installed Under This Section

Supervise and coordinate the installation of components furnished under this Section but installed under other Divisions of the specifications.

1. Automatic control valves, thermowells, liquid flow switches, and liquid flow sensors are to be installed under applicable piping section.
2. Automatic dampers, airflow measuring devices and fire dampers are to be installed under Section 15895 "Air Supply, Distribution, Ventilation and Exhaust System".

#### 1.3.3 Verification of Dimensions

The Contractor shall become familiar with all details of the work, shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

#### 1.3.4 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, shall arrange such work accordingly, and shall furnish all work necessary to meet such conditions.

#### 1.4 DELIVERY AND STORAGE

Products shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants, within the storage-condition limits published by the equipment manufacturer. Dampers shall be stored so that seal integrity, blade alignment and frame alignment are maintained.

#### 1.5 OPERATION MANUAL

An HVAC control system operation manual for each HVAC control system, in indexed booklet form, shall be provided. The operation manual shall include the HVAC control system sequence of operation, and procedures for the HVAC system start-up, operation and shut-down. The operation manual shall include as-built HVAC control system detail drawings. The operation manual shall include the as-built controller configuration checksheets, the as-built time clock configuration checksheet, the HVAC control system front panel description, the procedures for changing HVAC system controller set points, the procedures for gaining manual control of processes, the time clock manufacturer's manual control of processes, the time clock manufacturer's operation manual, and the controller manufacturer's operation manual.

- a. The HVAC control system front panel description shall explain the meaning and use of the lights, switches, gauges, and controller displays located in the front panel. Each light, switch, gauge, and display described shall be numbered and referenced to a drawing of the front panel.
- b. The procedures for changing HVAC system controller set points shall describe the step-by-step procedures required to change: the process variable set points of controllers, the alarm set points of controllers, the controller bias settings, and controller set point reset schedules.
- c. The procedures for gaining manual control of processes shall describe step-by-step procedures required to gain manual control of devices and manually adjust their positions.

#### 1.6 MAINTENANCE AND REPAIR MANUAL

An HVAC control system maintenance and repair manual for each HVAC control system, in indexed booklet form in hardback binders, shall be provided. The maintenance and repair manual shall include the routine maintenance checklist, a recommended repair methods list, a list of recommended maintenance and repair tools, the qualified service organization list, the as-built commissioning procedures and report, the as-built performance verification test procedures and report, and the as-built equipment data booklet (EDB).

- a. The routine maintenance checklist shall be arranged in a columnar format. The first column shall list all devices listed in the equipment compliance booklet (ECB), the second column shall state the maintenance activity or state no maintenance required, the third column shall state the frequency of the maintenance

activity, and the fourth column for additional comments or reference.

- b. The recommended repair methods list shall be arranged in a columnar format and shall list all devices in the equipment compliance booklet (ECB) and state the guidance on recommended repair methods, either field repair, factory repair, or whole-item replacement.
- c. The as-built equipment data booklet (EDB) shall include the equipment compliance booklet (ECB) and all manufacturer supplied user manuals and information.
- d. If the operation manual and the maintenance and repair manual are provided in a common volume, they shall be clearly differentiated and separately indexed.

## PART 2 PRODUCTS

### 2.1 MATERIAL AND EQUIPMENT

Material and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization. The Contractor shall submit a certified list of qualified permanent service organizations and qualifications. These service organizations shall be reasonably convenient to the equipment on a regular and emergency basis during the warranty period.

### 2.2 SYSTEM PERFORMANCE

The system shall conform to the following performance standards:

- 1. Graphics shall display with a minimum of 20 dynamic current data points and within 10 seconds of the request.
- 2. The maximum time between the command of a binary object by the operator and the reaction by the device shall be 10 seconds. Analog objects shall start to adjust within 10-seconds of being commanded to change.
- 3. All changes of state or change of analog values shall be transmitted such that no reporting of a value is more than 15 seconds old.

4. The maximum time from when an object goes into alarm to when it is annunciated at the B-OWS shall not exceed 20 seconds. Those points denoted as critical shall be annunciated in 2 seconds.

5. B-BC, B-AAC, and B-ASC shall be able to execute control loops at a selectable frequency at least 5 times every second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.

6. All B-OWS on the network shall receive alarms within 5-seconds of each other.

a. Each controller/sensor combination shall be selected and designed to perform within the accuracy and repeatability limits specified herein.

b. Unless noted otherwise in these Specifications the overall combined system accuracy of sensors, controllers and readout devices shall be noted in Table 1.

Table 1 - System Accuracy

Measured Variable	Reported Accuracy
Space temperature	+/-0.5 degree C (+/-1 degree F)
Ducted air	+/-1/0 degree C (+/-2 degree F)
Outside air	+/-1/0 degree C (+/-2 degree F)
Water temperature	+/-0.5 degree C (+/-1 degree F)
Delta-T	+/-0.15 degree C (+/-0.25 degree F)
Relative humidity	+/-3% RH 10-95% RH
Water flow	+/-2% of actual valve
Air flow (terminal)	+/-10% of actual valve (Note 1)
Air pressure (ducts)	+/-25 PA (+/-0.1 WG)
Air pressure (space)	+/-3 PA (+/-0.01 WG)

### 2.3 CONTROL SYSTEM APPLICATION SOFTWARE

The Control System Application software and database is to be stored on B-OWS hard disk drive.

#### Password Protection:

1. Multiple-level password access protection shall be provided.
2. Passwords shall be exactly the same for all operator devices, including portable or panel mounted network terminals.
3. A minimum of five levels of access shall be supported.
4. A minimum of 50 passwords shall be supported at each B-OWS and B-BC.
5. Operators will be able to perform only those commands available for their respective passwords.

6. User-definable, automatic log-off timers of from 1 to 60-minutes shall be provided to prevent operators from inadvertently leaving devices on-line.

7. All system security data shall be stored in an encrypted format.

Alarming and Event Notification:

1. B-OWS terminal shall provide audible, visual, and printed means of alarm and event notification.
2. System shall provide log of notification messages. Alarm log shall be archived to the hard disk of the system B-OWS.
3. Alarm messages shall be in user-definable text (English or other specified language) and shall be entered either at the B-OWS terminal or via remote communication.
4. An alarm summary shall be available to show all alarms whether or not they have been acknowledged.
5. Alarm programming shall include level, message, notification locator, routing, Change of State (COS) value, and de-bounce.
6. Each defined point shall have assignable alarm states.

Provide the capability to schedule each object or group of objects in the system. Each schedule could consist of the following:

1. Provide separate schedules for each day of the week.
2. Provide the ability for the operator to designate any day of the year as an exception schedule.
3. Provide the capability for the operator to define up to special or holiday schedules.
4. There shall be a provision with proper password access to manually override each schedule.
5. B-OWS shall be able of synchronize the Time and Date of any BACnet device on the BACnet internetwork that supports the Time of Day functionality. It shall be possible to command a single device or groups of devices simultaneously across the internetwork.

The system shall include a software program to perform optimized start-up and shutdown of selected equipment. The Start-Stop-Optimization (SSTO) program shall operate on outside weather conditions as well as inside zone condition, and empirical factors. The SSTO program shall operate in both the heating and cooling seasons. The system operator shall be able to, for each system under control of the SSTO program, establish and modify the following parameters:

1. Occupancy period.

2. Heating/cooling transfer coefficients.
3. Desired occupancy temperature.
4. Primary equipment lag time.
5. Heating/cooling retention coefficients.

Electrical Demand Limiting:

1. The system shall include a software program to perform electrical demand limiting (EDL) by resetting HVAC system set points to reduce load while maintaining Indoor Air Quality (humidity, CO2) and comfort control in the space. The program shall automatically shed and restore loads to prevent the electrical demand from exceeding and operator set level.
2. Each load shall be programmed with maximum off time, minimum on time and minimum off time.
3. When maximum target is exceeded alarm shall sound; current demand in kilowatts displayed and printed out with time of occurrence on alarm printer.

Trendlog Information: Any system point either real or calculated shall be assignable to the historical trending program by periodically gathering historical samples of object data stored in the field equipment (global controllers, field controllers) and archive the information on the B-OWS terminal (server) hard disk.

The system shall monitor equipment status and generate maintenance messages based upon user designated run time, date of last PM, number of failures since last PM, date and time of last failure, starts and/or calendar date limits.

This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts shall be user-selectable.

All binary output points shall be protected from short cycling. This feature shall allow minimum on-time and off-time to be selected.

System Configuration, Set-Up and Definition:

1. Device and network status shall be displayed for any device on the BACnet internetwork.
2. B-OWS shall be able to stop any BACnet object on the BACnet internetwork from transmitting event or alarm notifications until a subsequent command is issued.
3. All control strategies and energy management routines shall be



definable by the operator.

4. B-OWS shall be able to back-up and restore the programming and data for any BACnet device on the BACnet internetwork. Users shall also have the ability to manually execute downloads of any or all portions of a device database.

5. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system.

6. Integrate B-GW (gateway) from chiller, boiler, PDUs and chimney automation system into the BACnet internetwork.

a. Provide the tools to create, modify and debug custom application programming.

#### Color Graphics:

1. Provide a color graphics package to allow the user to generate custom dynamic graphics for graphical representation of system design and system parameters.

a. A listed set of symbols and graphic slides shall be provided to allow operators to select from the graphics table to assist in graphic generation.

1) All color graphic display shall be dynamic with current point data automatically updated from the BACnet internetwork to the B-OWS work station without operator intervention.

2) The operator shall be able to manually adjust digital, analog or calculated values in the system, adjust values of control loops, and command points to local mode or release points to automatic mode.

b. The windowing environment of the B-OWS shall allow the user to simultaneously view several graphics at the same time to analyze total building operation, and/or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

c. Graphic generation software shall be provided to allow the user to add, modify, or delete system graphic displays. The system shall provide libraries of pre-engineered screens and symbols depicting mechanical system components.

2. The system shall be provided with fully automatic diagnostic procedures for verification of field communication. In the event of communications failure, the system shall AutoDial the condition to a remote operator. AutoDial out will repeat alarms while the situation remains unacknowledged.

#### 3. Control Summaries, Reports and Logging:

a. The system shall provide self-documentation reporting to summarize control strategies for any point or any user selected

group of points within the Control System.

b. The B-OWS shall provide reporting and logging functions for user defined point value and status information.

c. The B-OWS reporting package shall allow the user to configure the point information display in custom format.

BACnet Conformance: B-OWS terminal shall comply with the requirements of a BACnet profile for B-OWS.

#### 2.4 OPERATOR WORK STATION (B-OWS)

Hardware and Operating System: B-OWS common database and graphic files shall be stored on a PC based operators work station designated and acting as the system server consisting of the following:

1. 1-GHz Pentium IV processor.
2. 256-MB RAM.
3. 1.44-MB, 3.5-inch diskette drive.
4. 20-Gigabyte or larger hard disc drive with 12-millisecond access time.
5. A high-density removable storage device capable of 10-MB storage on a removable cartridge. Acceptable devices include Iomega Zip or JAZ drives, tape storage or CD-RW.
6. Enhanced style keyboard with 101 key layout, 10 function keys, operate numeric keypad and separate cursor control pads.
7. Tower case with at least two spare drive slots and three spare board slots.
8. A 17-inch diagonal screen non-interlaced SVGA monitor with 0.28-mm minimum dot pitch and at least 1024\*768 resolution, a fully adjustable tilting base, separate control for color, contrast and brightness and non-reflective screen.
9. SVGA video output with 4-MB video RAM.
10. Two button mouse with adjustable sensitivity and desk pad.
11. CD-RW drive.
12. Internal 56 K BPS modem.
13. All required cables.
14. At least one spare serial port.
15. A combination surge suppressor/ UPS dedicated to this server and printer.

16. All communication ports to connect all devices here and networked communications from the control system.
17. Provide an integral audio tone generator to activate on detection of an alarm. Audio tone shall be capable of being enabled or disabled on operator command.
18. Microsoft Windows 2000 or NTv4.0 including Internet Explorer.
19. Microsoft Office 2000 Professional.
20. Microsoft Active X.

Control System Application Software: Provide licensed copy of Control System Application Software described in Paragraph "Control System Application Software".

Communications and Protocols:

1. B-OWS information access for the control system shall utilize the BACnet protocol exclusively.
2. B-OWS shall reside on the same LAN as B-BC's. B-OWS shall as a minimum support point-to-point (PTP) and either ARCnet ASTM751 or Ethernet ISO 8802-3. Physical/data link layer protocols.
3. The B-OWS specified here may, at the Owner's option, be located remote from the BACnet internetwork. Other than the difference in B-OWS communication speed, the system shall be capable of remote operation via BACnet LAN types with no degradation in application performance.

2.5 PORTABLE OPERATORS WORK STATION (B-POWS)

Hardware and Operating System:

1. Provide at least one PC compatible notebook of the following minimum configuration:
  - a. 100-MHz Pentium III processor.
  - b. 64-MB RAM.
  - c. 10-Gigabyte hard disk storage.
  - d. 3.5-inch 1.44-MB floppy disk drive.
  - e. CD-RW.
  - f. 14.1-inch TFT SVGA screen.
  - g. On board mouse.
  - h. On board modem 56.6-K.
  - i. On board LAN connection to B-OWS BACnet LAN type.
  - j. Rechargeable battery.
  - k. 120-volts AC power supply and cord.
  - l. Spare serial and parallel ports.
  - m. Carrying case.
  - n. Rechargeable extra battery.

2. Provide identical OS and third party application software as provided for the B-OWS.

Control System Application Software: Provide licensed copy of Control System Application Software described in Paragraph "Control System Application Software".

Communications and Protocols:

1. B-POWS information access shall utilize the BACnet protocol exclusively.
2. B-POWS shall as a minimum support point-to-point (PTP) and either ARCnet ASTM751 or Ethernet ISO 8802-3. Physical/data link layer protocols.
3. Remote LAN communications package shall be possible allowing offsite reporting and control through standard BACnet LAN types. Provide the connection devices for each B-POWS to connect with LAN.

## 2.6 PRINTERS

The system shall accept line printers with a serial interface for offsite alarming and reporting, and either serial or parallel interface for on-site alarming and reporting.

Display and report printer shall be 600 x 600 dpi, minimum 10 sheets per minute b/w laser printer with 8-1/2 x 11-inch A4 and legal sized 8-1/2 x 14-inch paper trays. Provide 2,000 sheets 8-1/2 x 11-inch pager/printer at time of acceptance.

Alarm printer shall be one dot matrix or equivalent line printer 8-1/2 x 11-inches with either fan feed or standard 8-1/2 x 11-inch individual feed and 240-characters/second printer speed.

## 2.7 SERVICE TOOLS

Hardware and Operating System:

1. Provide, at a minimum, one of each proprietary hardware and/or software tools required to service the system, including all manuals and licenses. In the case of multiple type service tools, one of each type shall be provided.
2. Provide 1-year supply of all required lubricants for components of the system including valves and dampers.

Communication and Protocols: Universal, two way, hand held service tool shall communicate with all microprocessor based controllers in the Control System. When connected the service tool may connect to multiple controllers simultaneously via the BACnet internetwork.

## 2.8 LAN TYPES AND COMMUNICATIONS

This Control System shall comprise a BACnet internetwork, as described in Part 1.

Each BACnet device shall operate on the BACnet physical/data link protocols specified for that device. Physical/data link protocol types utilized for communications exchange throughout the system will be limited to those LAN types described in the ANSI/ASHRAE Standard 135-1995, BACnet. BACnet LAN types are the following:

- 1 BACnet IP.
2. Ethernet (10Mbps/100 Mps)(IEEE 802.3) via 10BASE-T, 10BASE-2, 10BASE-5, and 10BASE-F.
3. ARCnet (ANSI/ATA 878.1) via COAX, Fiber or RS-485.
4. Master Slave/Token Passing (MS/TP) via RS-485.
5. LONTalk (EIA-709.1).
6. Point-to-Point via RS-232 or Modern connection.

The Controls Contractor shall provide all communication media, connectors, repeaters, modems, switches, hubs, bridges and routers and half-routers necessary for the BACnet Internetwork.

## 2.9 BACNET PROTOCOL VERIFICATION SOFTWARE

The System contractor shall as part of this contract provide a licensed copy of a BACnet Protocol Analyzer. This software shall be installed on at least one of the owners Ethernet or ARCNET connected BACnet Operator Work Stations (B-OWS). Should no BACnet Protocol packets be visible on the BACnet Internetwork then the system as installed will be rejected.

## 2.10 BUILDING CONTROLLERS (B-BC)

Hardware and Operating System:

1. B-BC shall provide battery-backed distributed processing unit and shall monitor and manage input and output communication signals allowing B-AAC's and B-ASC's to share real and virtual information and allow for central monitor and control. B-BC shall provide real-time (hardware) clock functions and perform scheduling.
2. B-BC shall be capable of deciding global strategies for the system based on information from any objects in the system. Control Systems that require a higher-level host processor for update, time stamps, global point data, COS transfer, on-line control instruction, or communications control between B-BC panels shall not be acceptable.
3. B-BC shall be capable of either discriminately or indiscriminately sharing global data with other B-BC and B-OWS on the BACnet internetwork.

4. Provide means to graphically simulate inputs and outputs to each program in real-time as program is executing. This function may be performed via any B-OWS.

5. B-BCs shall have sufficient memory to support its operating system, database, and programming requirements. Battery shall retain static RAM memory and clock functions for a minimum of 72-hours. B-BC operating system, field database, and application programs shall reside in on-board memory or EEPROM.

6. Provide diagnostic LEDs for power, communications and processor. The B-BC shall continually check the status of its processor and memory circuits.

#### Control System Application Software:

1. The controller software shall reside in a real time, multi-tasking, networking operating environment. Database definition shall be accomplished through the B-OWS online with the B-BC. The complete database and application program shall reside in the B-BC. The System Contractor shall configure the software to attain the proper sequence of control and to accomplish all other control system functions indicated in the Contract Documents. The user shall be able to add, delete, or edit objects on-line as required. The programming shall provide all the necessary mathematics, logic, utility and control functions necessary for proper sequence of control.

2. The software defined within the B-BC, in conjunction with the stand alone control loops residing within the B-AAC and B-ASC shall provide all required application programming.

3. Alarm management shall be provided. Each B-BC panel shall perform distributed, independent alarm analysis and filtering. At no time shall the B-BC panel's ability to report alarms be affected by either operator activity at a B-OWS or local I/O device, or communications with other B-BC on the network.

- a. B-BCs shall have capability to call out alarm conditions automatically. Alarm message and site description shall be sent to off-site computer or serial printer. If desired, controller may also send encoded message to digital pager.
- b. Alarms log viewable on site or remotely shall be provided.
- c. All alarm or point change reports shall include the point's English language description, and the time and date of occurrence.
- d. The user shall be able to define the specific system reaction for each point alarm and shall be able to customize reaction and filtering to minimize nuisance reporting. Each B-BC panel shall automatically inhibit the reporting of selected alarms during the standby power modes of operation, loss of power, fire alarm mode, and normal system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.
- e. Alarm reports, messages, and files can be directed to a user-defined list of operator devices, or PCs used for archiving alarm information.

4. A variety of historical data collection utilities shall be provided. Minimum sampling time shall be programmable with a minimum programmable time of 1-second.
  - a. B-BC panels shall store point history files for all analog and binary inputs and outputs.
  - b. Measure and calculate analog and binary data shall also be assignable to user-definable trends.
  - c. Trend data shall be stored at the stand-alone B-BC panels, and uploaded to hard disk storage when archival is desired.
5. Stand-alone B-BC panels shall automatically accumulate and store runtime hours for binary input and output points.
6. B-BC panels shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.
7. B-BC panels shall have the ability to count events on a daily, weekly, or monthly basis.
8. Demand Limiting:
  - a. System shall monitor energy demand from any type of energy source. Networked B-BC shall provide a demand-limiting routine that shall shed appropriate system objects to prevent the demand from exceeding preset limits.
  - b. Zone shed method shall be by either preventing zone heating and cooling operations, or by shifting zone heating and cooling set points.
9. The B-BC shall meet BACnet profile for Building Controllers.

Communication and Protocols:

1. Each B-BC shall reside the same BACnet LAN type as B-OWS.
2. The B-BC shall continuously scan the BACnet Internetwork and maintain a current database of field data in on board battery backed RAM or EEPROM. The B-BC shall coordinate transfer of data between B-OWS and/or B-BC.
3. The B-BC shall provide a communications port for connection of the Portable Operators Terminal using Point to Point BACnet physical/data link layer protocol or a connection to the inter-network.
4. The B-BC shall provide a communication port for connection of a B-POWS using either ISO 8801-3 internet or ARCnet (ASTM878.1).
5. Provide all functions that will allow remote communications via modem to off-site locations. Include modem along with all cabling necessary for installation.

## 2.11 ADVANCED APPLICATION CONTROLLER (B-AAC)

## Hardware and Operating System:

1. The primary device for input/output connection to the field sensors, and control devices shall be a B-AAC. Each B-AAC shall acquire, process and store point input data on a real time basis for internal use and for upload to the B-BC. Each B-AAC shall also maintain and supervise digital and analog output signals to the control devices and have a real time operating system capable of time of day scheduling and other time based functions.
2. B-AAC shall provide microprocessor based self-contained stand-alone fully programmable operation of local process control loops. All local level application programs shall be installed on individual controllers in non-volatile memory. Each B-AAC shall be capable of sharing point information with other B-BC, B-AAC, or B-ASC on the BACnet internetwork.
3. Control systems that require communication between B-AAC or B-ASC and a B-OWS or B-BC for normal control functions, or which operate in a degraded mode without those level communications, or which require programmable read only memory (PROM) level application programming are not acceptable.
4. Once downloaded, a B-AAC shall not require further communication with the B-OWS except for data base changes, operator commands, and requests from the B-OWS for B-AAC data. Programming of B-AACs shall be completely modifiable in the field, over installed BACnet Internetwork or remotely via modem.
5. The B-AAC to be expandable by adding Input/Output logic modules or Input/Output expansion modules.
6. All wiring shall be connected to padded screw terminals or labeled spade connections.
7. Input/Output Configuration:
  - a. Analog Inputs: Industry standard 4 to 20-mA, 0 to 5-volts, 0 to 10-volts, 3 to 15 psi and thermistor or RTD analog sensors. A/D conversion to be a minimum of 10 bit resolution. AI circuits will be electrically isolated.
  - b. Analog Outputs: Provide modulating signal to industry standard 3 to 15 psi, 4 to 20-mA, 0 to 5-volt and 0 to 10-volt analog control devices. Digital to analog conversion with a minimum of 10 bit resolution. All AOs shall have physical hand-off-auto switched located within the B-AAC control enclosure. Provide a means of incrementally positioning analog outputs when the switch is in hand. H-O-A switch shall be hardware monitored by the B-AAC for switch position.
  - c. Digital Inputs: Accept non-powered, binary contact closure signals. DI circuit shall be electrically isolated.
  - d. Digital Outputs: Electrically isolated maintained or momentary electrical relay. All DOs shall have physical



hand-off-auto switched located within the B-AAC control enclosure.

H-O-A switch shall be hardware monitored by the B-AAC for switch position.

e. Pulse accumulation input points shall conform to all the requirements of Binary Input points, accept up to ten pulses per second for pulse accumulation, and shall be protected against effects of contact bounce and noise.

f. Each B-AAC shall have a minimum of 10-percent of its I/O functions as spare capacity, but not less than two of each type used on each. The type of spares shall be in the same proportion as the implemented I/O functions on the panel, but in no case shall there be less than two spare points of each type.

8. Provide diagnostic LEDs for power, communications and processor.

9. Each B-AAC shall be provided with the ability to prevent unauthorized access to its software program.

10. Each controller shall be addressable.

11. The B-AAC shall meet BACnet profile for Advanced Application Controller.

12. Each controller shall have "power on" indicator.

#### Control System Application Software:

1. The controller software shall reside in a real time, multi-tasking, networking operating environment. Database definition shall be accomplished through the B-OWS online with the B-AAC. The complete database and application program shall reside in the B-AAC. The System Contractor shall configure the software to attain the proper sequence of control and to accomplish all other control system functions indicated in the Contract Documents. The user shall be able to add, delete, or edit objects on-line as required. The programming shall provide all the necessary mathematics, logic, utility and control functions necessary for proper sequence of control.

2. The software defined within the B-AAC, in conjunction with the stand alone control loops residing within the B-BC and B-ASC shall provide all required application programming.

3. Alarm management shall be provided. Each B-BC panel shall perform distributed, independent alarm analysis and filtering. At no time shall the B-AAC panel's ability to report alarms be affected by either operator activity at a B-OWS or local I/O device, or communications with other B-BC on the network.

a. B-AACs shall have capability to call out alarm conditions automatically. Alarm message and site description shall be sent to off-site computer or serial printer. If desired, controller may also send encoded message to digital pager.

b. Alarms log viewable on site or remotely shall be provided.

c. All alarm or point change reports shall include the point's

English language description, and the time and date of occurrence.

d. The user shall be able to define the specific system reaction for each point alarm and shall be able to customize reaction and filtering to minimize nuisance reporting. Each B-AAC panel shall automatically inhibit the reporting of selected alarms during the standby power modes of operation, loss of power, fire alarm mode, and normal system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.

e. Alarm reports, messages, and files can be directed to a user-defined list of operator devices, or PCs used for archiving alarm information.

4. A variety of historical data collection utilities shall be provided. Minimum sampling time shall be programmable with a minimum programmable time of 1-second.

a. B-AAC panels shall store point history files for all analog and binary inputs and outputs.

b. Measure and calculated analog and binary data shall also be assignable to user-definable trends.

c. Trend data shall be stored at the stand-alone B-AAC panels, and uploaded to hard disk storage when archival is desired.

5. Stand-alone B-AAC panels shall automatically accumulate and store runtime hours for binary input and output points.

6. B-AAC panels shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.

7. B-AAC panels shall have the ability to count events on a daily, weekly, or monthly basis.

8. Demand Limiting:

a. System shall monitor energy demand from any type of energy source. Networked B-AAC shall provide a demand-limiting routine that shall shed appropriate system objects to prevent the demand from exceeding preset limits.

b. Zone shed method shall be by either preventing zone heating and cooling operations, or by shifting zone heating and cooling set points.

9. The B-AAC shall meet BACnet profile for Building Controllers.

Communications and Protocols: B-AAC shall as a minimum support one BACnet LAN type communicating at a minimum of 9,600 baud as native BACnet device.

## 2.12 APPLICATION SPECIFIC CONTROLLER (B-ASC)

Hardware: B-ASC hardware shall be the same as B-AAC and indistinguishable with the exception that there is no requirement to have expansion I/O modules or H-O-A overrides on outputs within the control enclosure.

Control System Application Software: Shall be the same as B-AAC with the exception that BACnet profile is changed to B-ASC instead of B-AAC, and B-AAC may have firmware specifically dedicated to control a specific piece of mechanical equipment.

Communication and Protocols: Shall be the same as B-AAC.

#### 2.13 LOCAL I/O

A local keypad and display shall be provided where specified in the sequence of operations or points list. Keypad shall be provided for interrogating and editing data. An optional system security password shall be available to prevent unauthorized use of the keypad and display.

#### 2.14 CONTROL ENCLOSURES AND SUB-PANELS

Provide pedestal base or wall mounted local control enclosure to house all control components associated with each area, system or mechanical equipment room. The enclosures shall be minimum 16-gauge steel or aluminum bonded on both sides to a plywood core, totally enclosed on all sides and painted with a baked enamel finish. Provide a continuous piano hinged door, keyed locking latch and removable sub-panel. A single key shall be common to all control enclosures. Enclosures shall be the same NEMA classification as all other enclosures located in the same environment, except if location requires additional protection due to potential vandalism or environmental conditions. At a minimum, enclosures located in dry indoor conditions shall conform to NEMA 1 standards. Enclosures located in wet indoor conditions such as garages or located outdoors shall be fully gasketed and shall conform to NEMA 3R standards.

Provide intrusion detection device, connected as an alarm.

Provide Duplex Outlet: Single phase, 120-volt AC electrical service outlet for use with test equipment shall be furnished either inside or within 6-feet of the control panel enclosure.

Provide main power switch.

Provide laminated nameplates for all control system components. Nameplates shall be 1/8-inch thick, black, with white-center core, and shall be minimum 1 x 3-inches, with minimum 1/4-inch high block lettering. Nameplates for devices smaller than 1 x 3-inches shall be attached to adjacent surface.

#### 2.15 DAMPERS

Dampers (control) shall be factory fabricated and shall have flow control characteristics required by each individual application. For modulating dampers under actual operating conditions, provide type which produces a linear relationship between the air flow and operating range.

1. Damper frame shall be made of minimum No. 14 gauge galvanized steel formed into channels and welded or at least 4-1/2-inch x 1-inch x 1/8-inch thick extruded aluminum.

2. Dampers shall be constructed with blades of formed zinc coated minimum 16-gauge steel or 6-inch x 0.08-inch extruded aluminum, with factory assembled linkages, mounted in bar or channel frames of zinc coated steel or extruded aluminum. Where blades are mounted vertically, support by thrust bearings. All blades on each damper shall be furnished with polyurethane edging.

3. Damper shall have neoprene or stainless steel damper seals at all blade edges and ends suitable for an operating range down to 0 degree F at the lower end and 200 degree F at the upper end. Axis shall be minimum 1/2-inch diameter and be locked to blade with rivets or welded.

4. All dampers shall be provided with nylon, cyclopy or iolite bearings.

5. Where rectangular dampers are 12-inches or more in a direction perpendicular to the axis, use sectionalized type with blade width not exceeding 8-inches. Where rectangular damper is larger than 4 square feet in area, use corner braces. Blade length is not to exceed 48-inches.

6. Dampers, when closed, shall not leak in excess of 10 cubic feet per minute per square foot at 4-inches WG static pressure differential and be so certified by the manufacturer. Furnish damper operators having sufficient power to limit leakage to the rate specified. Provide a minimum of one operator per 25 square feet of damper area.

7. Operating line, i.e., connecting rods transmitting motion from damper motors to damper, shall be sized to withstand a load equal to at least twice the maximum damper operating force without deflection. Make length adjustable and construct from brass, bronze or steel. For zinc-coated or cadmium plated steel links, construct working parts of joints, e.g., pins, clevises and ball-and-socket joints from bronze or stainless steel.

8. Provide for adjustment for blade travel in either direction.

9. Factory finish parts of steel damper with two coats of rust inhibitive paint.

10. Provide damper position indication consisting of potentiometer mounted in housing.

## 2.16 DAMPER ACTUATORS

Control damper actuators shall be electronic direct-coupled type. Actuators shall have a reversing switch and a manual override accessible at the front cover.

Single bolt or setscrew type fasteners are not acceptable.

The actuator shall have electronic overload or digital rotation sensing circuitry. Mechanical end switches or magnetic clutch to deactivate the

actuator at the end of rotation are not acceptable.

Actuators shall have a spring return mechanism unless specified otherwise or pre-approved by Engineer. Internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms operation is not acceptable.

Actuators with more than 60-inches-pound torque capacity shall have a manual crank release to allow manual positioning of the damper when the actuator is not powered.

All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation.

Provide visual mechanical position indicators.

Actuators shall smoothly open or close device, which they are applied and shall have full stroke run time of 90-seconds or less (unless otherwise noted or pre-approved by Engineer).

## 2.17 CONTROL VALVES

### General Requirements:

1. Valves shall be provided with metallic linkage.
2. All valves shall provide tight shut-off when in the closed position.
3. Unless otherwise indicated all valves shall have a minimum rangeability of 50 to 1. All valves shall be guaranteed to have not more than 1-percent leakage of design flow rate at the pump shut-off pressure.
4. The shaft packing must be capable of sealing at 1.5 times the pressure vessel rating.
5. Globe valves shall have replaceable seats.
6. Valves shall be quiet in operation.
7. Valves shall have body, disc, stem and stuffing box designed for 150-percent of the piping system's working pressure, but in no case less than ANSI 150-pounds per square inch and maximum fluid temperature of 350 degF.
8. Certify all valves to be functionally tested, to include cycling the valves and topworks, measuring seating torque and verifying leak tight performance of the seat.
9. Certify the valve is capable of thermal cycling over its complete pressure/temperature range.
10. Provide limiting device to restrict valve travel where required to maintain system flow characteristics.

11. Two and three-way electronic terminal unit zone valves (1/2 through 3/4-inch) shall be provided with adjustable Cv capability.

Ball Control Valves (1/2 through 3/4-inches):

1. Pool Heating Water Application (1-1/2-inches): All CPVC ball valves, fitted with electronic actuator, EPDM seals.
2. All Other Applications:
  - a. Valves shall be forged brass or bronze body with nickel plating, NPT screw type or union end or flare connections.
  - b. All control ball valves shall be furnished with chrome plated bronze ball and stainless steel stem and fiberglass reinforced Teflon seats and seals. The valves shall have a blow out proof stem design.
  - c. The stem packing shall be two O-rings designed for modulating service and requiring no maintenance.

Two and Three-Way Electronic Globe Valves (1/2 through 2-inches): Valves shall be bronze or cast iron body, NPT screw type or union end or flare connections. Spring-loaded packing shall protect against leakage at the stem.

Two and Three-Way Electronic Globe Valves (2-1/2 to 4-inches flanged): Valves shall be iron body, cast iron, or cast steel, flanged type. Packing shall protect against leakage at the stem.

Two and Three-Way Electronic Butterfly Valves (5-inches and larger, flanged):

1. Pool Heating Water Application: All CPVC butterfly valves, fitted with electronic actuator, EPDM seals.
2. All Other Applications:
  - a. Valves 4-inches and larger shall be fully lugged cast iron body.
  - b. Flanges shall meet all ANSI 250 standard.
  - c. The stem shall be one-piece stainless.
  - d. The 416 stainless shaft shall be supported at three locations with PTFE bushings for positive shaft alignment.
  - e. The seat shall be EPDM; Phenolic backed, non-collapsible, and easy to replace.
  - f. The disc shall be aluminum bronze to provide bubble-tight close off in either direction.
  - g. Valve shall have a long stem design to accommodate 2-inch insulation.

## 2.18 VALVE ACTUATORS

Actuators used in or near outdoor air streams shall have NEMA 2 housings.

The actuator shall be modulating; floating (tri-state) or two-position as called out in the control sequence of operation. Actuators shall be spring return unless specified otherwise or approved by Engineer. All modulating valves shall be positive positioning, and respond to a 2 to 10-volt DC or 4 to 20-mA with a load resistor with the exception that terminal unit zone valves may use an actuator that responds to a floating or tri-state signal.

All control valves shall have a visual position indicator.

Actuators shall have a manual crank to allow manual positioning of the damper when the actuator is not powered. Three bypass shut off valves shall be provided to allow the control valve to be isolated while the open stop valve in the bypass allows flow around the control valve.

All modulating actuators shall have an external, built-in switch to allow the reversing of direction of rotation.

Actuators shall be equipped with electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.

Actuators shall smoothly open or close device, which they and shall have full stroke runtime of 90-seconds or less (unless otherwise noted or pre-approved by Engineer).

## 2.19 ELECTRONIC SENSORS

### 2.19.1 Temperature Sensors

Analog Temperature Sensors:

#### 1. General Requirements:

- a. Sensors shall provide an output signal that varies linearly and continuously with sensed temperature.
- b. Sensors shall be 1,000-ohm platinum resistance (RTD) type or Thermister type, calibrate to 0.2-percent accuracy at calibration point.
- c. RTD sensors shall be nickel or platinum wound wire, hermetically encapsulated in copper or glass-epoxy enclosure and corrosion resistance, to sensed media.
- d. Sensors shall operate throughout range and accuracy subsequently listed.
- e. Sensors shall have time constant response to achieve 63-percent of a step temperature change in 6-seconds in water flow at 3-feet per second.

2. Single point duct temperature sensor shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise.

3. Averaging type shall be used in ductwork with any dimension greater than 48-inches or where air temperature stratification may occur, to

obtain average temperature by continuously sampling along 8-foot or 17-foot capillary length. The averaging sensor shall have a bendable 3/8-inch OD probe, with numerous sensors encapsulated at equal distances across the length of the probe, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Locate elements where responsive to representative temperature and provide with firm support and insulate from direct contact with coils or other heat conductors. Protect capillaries where exposed to damage with flexible armor or conduit.

4. Liquid immersion temperature sensor shall include thermowell, sensor and connection head for wiring connections. Sensor shall be stem sensitive mounted in brass, copper or stainless steel separable thermowells with extension necks where required for insulation. Thermowells shall include thermal transmission media compatible with sensor and shall be located where responsive to representative temperature.

5. Outside air sensor is single device sensor shall be designed to withstand ambient environmental conditions. Sensing element shall be shielded by ventilated non-metallic shield to withstand wind velocity pressures and direct sun exposure. Outside air temperature sensor shall be provided with utility box for terminations, and watertight gasket to prevent water seepage. Transmitter shall be of NEMA 3R construction and rated for ambient temperature.

6. Room type shall be 10,000-ohm thermistor sensor, accuracy as listed, at calibration point (adj., degree F). Sensing element shall be mounted within a ventilated cover. Provide sensor with set point adjustment dial or push button, override switch, LAN connection, service tool connection and LED display when located in offices, classrooms, weight training room, fitness room, etc. Provide sensor with override switch only for public spaces such as corridors, lobbies, lockers, toilet rooms, etc. Sensors located in mechanical areas, plenums, lobbies, or other public spaces shall simple sensor with no set point adjustment. Sensors shall be mounted at 5-foot height unless otherwise directed. Sensors accuracy shall be unaffected by wiring up to 250-feet. Sensor guards shall protect sensor from damage expected in area or limit access to sensor. Insulated mounting base shall prevent temperature of mounted wall or drafts due to outside wall mounting from effecting sensor temperature.

#### Binary Temperature Sensors:

##### 1. General Requirements:

- a. Sensors shall be bimetal or capillary type liquid fill or vapor tension, actuating one or more switch contact. Contacts shall be rated for pilot duty or imposed load.
- b. Capillary type thermostats shall consist of platinum sensing element, connected to a fully compensating capillary tube, and operating bellows or spiral.
- c. Sensors shall have adjustable set point throughout range of minus 50 degF to plus 250 degF with adjustable differential



between contact stages as required by application.

d. Sensor shall be housed in NEMA enclosure suitable for environment, and corrosion resistant to sensed media.

e. Sensors shall be automatic or manual reset type.

2. High limit sensor shall be manual reset type. Sensing element shall be bimetal.

3. Low temperature limit sensors shall be bi-metallic type with sensing element 18-inches long or of the vapor pressure remote element with sensing element shall be minimum 20-feet long. Low limit sensor shall be, manual reset type with adjustable set point.

4. Freeze protection sensors (freezestat) shall be of manual reset type, which will respond to the lowest temperature to which any 1-foot portion of its 20-foot element is exposed. On multi-coil units, provide low limit sensor on each coil and wire in series. All freeze protection sensors shall have status feedback.

5. Surface mounted thermostats shall be line voltage on-off type suitable for strapped mounting to pipe.

6. Wall mounted thermostats shall be line voltage on-off type suitable for wall mounting.

#### 2.19.2 Humidity Sensors

Analog sensor shall be non-saturating buck polymer resistance change, thin polymer film capacitance change or chilled mirror technology type. Sensor shall have range of 10 to 90-percent with temperature limits of 40-to 140 degree F and accuracy +/-5-percent relative humidity. Humidity Sensors shall be suitable for duct, wall (room) or outdoor mounting and sensing element shall be protected. Unit shall produce linear continuous output for percent relative humidity (percent RH).

Binary sensor shall be moisture-sensitive nylon element, Form C contacts with adjustable set point over 20 to 85-percent relative humidity range with fixed differential of 5-percent relative humidity. Sensor shall be suitable for duct or room mounting (humidistat) with 40 to 120 degree F temperature limits. Contacts shall be rated for application consistent with switched voltage and power level.

Wet Bulb temperature and humidity station shall be suitable for duct or outside mounting and consist of sensors, ventilated non-metallic sun shield, utility box for terminations, and watertight gasket to prevent water seepage.

#### 2.19.3 Pressure Sensors

Analog Pressure Sensor/Transmitter:

##### 1. General Requirements:

a. Sensors shall be diaphragm or bellows type with solid-state

amplifier or variable resistance, and with the narrowest possible span available.

b. Sensor shall have over range capability or 150-percent of operating pressure and construction requirements of media sensed.

c. Sensors shall have +/-0 adjustment and be supplied with isolation valve, additional gauge tap and pigtails and/or blow downs as required.

d. Sensor shall have accuracy of +/-1-percent of span. Zero and span shall be field-adjustable.

2. Static Air Pressure Sensor shall have linear output voltage signal. Pitot tube probe shall be a brass with 8-inch lead tube allowing insertion into duct.

3. Water gauge pressure sensor shall include connections secured to a stainless steel diaphragm sensor with a gasketed, dust and watertight housing for remote mounting.

#### Binary Sensor (switch):

##### 1. General Requirements:

a. Sensors shall be Bourdon-tube diaphragm; paddle type or bellows type with snap-action form C contacts of platinum, silver or gold construction.

b. Sensor shall have adjustable set point and differential with over range capability of 150-percent of operating pressure.

c. Switch contact ratings shall be consistent with voltage and power levels and construction shall meet requirements of media sensed. Sensors shall be supplied with isolation valve, additional gauge tap and pigtails and/or blow downs as required.

2. Paddle type airflow switch shall have a one-piece stainless steel paddle to actuate a SPDT snap-acting switch. Paddle type airflow switch shall be used to verify airflow in constant volume systems only.

3. Paddle type water flow switch shall be SPDT snap acting with brass wetted parts. Sensitivity shall be externally adjustable without removing the assembly from the line.

#### 2.19.4 Differential Pressure Sensor

##### Analog differential pressure sensor/transmitter:

##### 1. General Requirements:

a. Sensors shall be bellow or diaphragm type with solid state amplifier or variable resistance and with adjustable span and +/-0 adjustment.

b. Sensor shall have over range capability of 200-percent of maximum operating differential pressure, and construction requirements of media sensed.

c. Sensors shall be supplied with five valve manifold additional gauge taps and blow downs as required. Five-valve manifold

assembly shall allow isolation and bypass of operating pressures from differential pressure sensor.

d. Sensor accuracy shall be +/-1-percent of span.

2. The differential pressure sensor for air applications shall provide a linear output voltage signal. The device shall be capable of over-pressurization to 10 PSID without a zero-shift and shall have a field adjustable zero and span. The assembly shall consist of pressure connections that secure pressure sensor to a housing for duct or remote mounting.

3. Differential Pressure Sensor for water shall consist of a differential pressure tap secured to a stainless steel diaphragm and an electronic sensor enclosed in a gasketed, dust and watertight case. The differential pressure transmitter for hot water system shall be placed where the maximum differential pressure requirement exists or as shown.

4. Snubber shall prevent system pressure hammers and surges from being fully transmitted to the pressure sensor.

#### Binary Differential Pressure Sensor/transmitter (switch):

##### 1. General Requirements:

a. Binary sensor shall be Bourdon tube, bellows or diaphragm type with snap action form C contacts of platinum, silver or gold construction.

b. Sensors shall have adjustable set point and differential with over range capability of 200-percent of operating differential pressure.

c. Switch contacts shall be consistent with voltage and power levels and construction shall meet requirements of media sensed.

d. Sensors shall be supplied with insulation valves, additional gauge taps and blow downs as required.

2. Differential pressure type air flow switch shall be diaphragm operated SPDT snap acting with adjustable set point. Switches used for shutdown shall be manual reset type.

3. Differential pressure indicating type air flow switch shall be same as differential pressure type with addition of a gauge and set point indicators visible on the gauge.

4. Differential pressure type water flow switch shall be SPDT or DPDT snap-acting, with enclosure.

#### 2.19.5 Carbon Dioxide Sensor

Carbon Dioxide sensor/transmitters for AHU systems shall have a range 0 to 2,000 ppm, scalable 0 to 10,000 ppm.

Provide a canister of calibration gas and a regulator.

#### 2.19.6 Current Sensors

Analog current sensor shall have field selectable range of 1 to 200-amps. Output shall be 1 to 5-volts DC or 4 to 20-mA for full range. Sensor shall produce output by measuring magnetic field above current carrying conductor. Sensor shall be rated for 600-volts.

Binary current sensing switch shall be self-powered with solid-state circuitry and have field-selected range from minimum 1-amp to unlimited maximum. Range shall be field adjusted by number of windings through sensor of current carrying conductor. Sensor shall detect magnetic field about current carrying conductor. Dry contact output shall be form C rated at 1-amp at 120-volts AC. Sensor shall be rated for 600-volts.

Current sensing switch shall contain SPDT relay and an LED for ON-OFF status indication.

#### 2.19.7 Electrical Power

Potential transformers shall be in accordance with ANSI C57.13 and shall be suitable for insulation class 15-kilovolt for 13.8-kilovolt applications, 5-kilovolt for 2.4-kilovolt applications and 1.2-kilovolt for 208-volt application and below. Secondary voltage shall be 120-volts. Transformer shall be fused on both sides.

Current transformers shall be provided for each phase or lead as indicated with insulation class as required for potential transformers. Current transformers shall conform to ANSI standard C.57.13 for metering, and shall be butyl-molded donut or window type mounted on suitable bracket in low voltage section with transformer secondaries identified and looped to permit field current measurement to be taken with hook-on-ammeters.

Current transferals shall have a 5-ampere secondary. Voltage and Current Sensors: Voltage and current transducers shall be solid-state analog type.

Sensors shall have adjustable span and accuracy 0.01-percent of span. Inputs shall be 0 to 120-volts AC for voltage and 0 to 5-amps for current with DC low voltage or milliamper output. Sensors shall have common mode rejection of 80 db at 60-Hz and 600-volts AC. Sensor shall be enclosed in butyrate case and mounted in plug in socket. Sensor shall have maximum temperature limit of 120 degree F.

Panel-mounted electric push button switch pilot light shall be oil tight, transformer type, with screw terminals.

Emergency shut-off switches shall be heavy duty, two-position push-pull, maintained contact, illuminated 1-3/8-inches in diameter mushroom style push button switch. Provide hinged easy open protective clear cover to prevent accidental operation of switch.

#### 2.19.8 Output Devices

Control relay contacts shall be rated for the application, with a minimum of two sets of Form C contacts, enclosed in a dustproof enclosure. Relays shall have silver-cadmium contacts with a minimum life span rating of one million operations. Operating time shall be 20-milliseconds or less, with

release time of 10-milliseconds or less. Relays shall be equipped with coil transient suppression limiting transients to non-damaging levels.

Time Delay Relay: Time delay relay contacts shall be rated for the application with a minimum of two sets of Form C contacts enclosed in a dustproof enclosure. Relays shall have silver-cadmium contacts with a minimum life span rating of one million operations. Relays shall be equipped with coil transient suppression devices to limit transients to non-damaging levels. Delayed contact opening or closing shall be adjustable from 1 to 60-seconds with a minimum accuracy of +/-2-percent of setting.

Latching relay contacts shall be rated for the application with a minimum of two sets of Form C contacts enclosed in a dustproof enclosure. Relays shall have silver-cadmium contacts with a minimum life span rating of one million operations. Operating time shall be 20-milliseconds or less, with release time of 10-milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to non-damaging levels.

Reed relays shall be encapsulated via a glass-type container housed in a plastic or epoxy case. Contacts shall be rated for the application. Operating and release times shall be 1-millisecond or less. Reed relays shall have a minimum life span rating of 10-million operations.

Contactors shall be on the single, coil, electrically operated, mechanically held type. Positive locking shall be obtained without the use of hooks, latches or semi-permanent magnets. Contacts shall be double-break silver-to-silver type protected by arcing contacts. Number of contacts and ratings shall be selected for the application. Operating and release times shall be 100-milliseconds or less. Contactors shall be equipped with coil transients to non-damaging levels.

Solid-State Relays shall have input-output isolation greater than 1,000-megohms with a breakdown voltage of 1,500 V rms or greater at 60-Hz. The contact life shall be 10-million operations or greater. The ambient temperature range shall be -20 to +140 degree F. Input impedance shall not be less than 500-ohms. Relays shall be rated for the application. Operating and release times shall be 1-millisecond or less. Transient suppression shall be provided as an integral part of the relay to limit transients to non-damaging levels.

#### 2.19.9 Interconnecting Wire and Cable

Wire and cable for power, interlock, communications, sensor, and control device wiring shall be as specified in Division 16, the National Electric Code, Network Standards, control system manufacturer recommendations, and applicable local codes.

#### 2.19.10 Weather Shields

Provide weather shields and outside air sensing elements with the following characteristics:

1. Mount elements and shields on the north face of the building or location out of direct sunlight.
2. Construct shields of 1/16-inch 316 stainless steel with 1/4-inch diameter stainless steel bolts. Mount backplate to the building structure with expansion bolts.
3. Construct shields to inhibit solar effects. Construct shields in a rectangular box configuration with ventilating raintight louvers to preclude the entrance of snow, ice and rain. Design for crossflow and vertical air circulation.
4. Mount shields accessible for maintenance.
5. Seal wall penetration watertight.

#### 2.19.11 Thermowells

Temperature transmitters shall be installed in thermowells with extension neck with union type nipple connectors where mounted in pipe lines or stacks unless otherwise specified. Thermowell shall be constructed of type 416 stainless steel. Unless specified otherwise, thermowells shall be suitable for socket weld insulation. Socket welding fitting shall be provided by others. Thermowells for mounting in stacks shall be tapered threaded type. The extension neck shall be selected based upon the adjacent insulation thickness.

### PART 3 EXECUTION

#### 3.1 GENERAL

Control System component locations are the responsibility of the System Contractor. All control system components shall be installed in locations as required to properly sense the controlled medium and shall be easily accessible for adjustment and service. All components shall be installed in accordance with the component manufacturers recommendations.

The system shall be installed such that all wiring, communication, analog or digital, input or output shall be capable of sharing single conduit runs without affecting signal performance.

The Contractor shall protect all work and material from damage by his/her work or workers, and shall be liable for all damage thus caused.

The Contractor shall be responsible for his/her work and equipment until finally inspected, tested and accepted. The Contractor shall protect his/her work against theft or damage, and shall carefully store material and equipment received on site that is not immediately installed.

After completion of installation, calibrate and commission all components provided as part of the Control System and demonstrate proper sequence of operation in compliance with Paragraph 1.6 "Calibration, Commissioning Demonstration and Acceptance". Equipment not operating correctly shall be field corrected or replaced.

### 3.2 CONTROL SYSTEM APPLICATION SOFTWARE

At time of acceptance all operating system, third party and Control System Application software shall be at least the latest version available.

Software programs are described to their general intent. It is recognized that Networked System manufacturers' software differ; however, the Application software provided shall incorporate the feature described fully implemented and optimized to provide the sequences described, minimize energy consumption and prolong equipment life.

The following naming convention shall be standards for the naming of BACnet Devices on the BACnet internetwork. The convention for object names viewed by B-OWS shall consist of a string made up of components indicating, as appropriate, the building location, the building, the system, the subsystem, and point function of the object.

When programming the system BACnet addressing rules will be strictly adhered to. All addressing strategies will have to be approved by the Owner's representative prior to terminating any LAN types.

All analog and binary values shall be programmed with appropriate alarms.

Except as specified otherwise, throttling ranges, proportional bands, and cycle differentials be centered on the associated set point.

All set points unless otherwise indicated are adjustable and shall be programmed for all control loops.

Each control loop or interlock for all mechanical system including terminal unit systems shall be programmed with a control loop specific graphical trend to trend all values associated with each specific control loop or system interlock.

Where any sequence or occupancy schedule calls for more that one motorized unit to start simultaneously, the system shall start commands shall be staggered by 60-second (adj.) intervals to minimize inrush current.

Scheduling shall be developed for each mechanical system and coordinated with Owner.

Optimal start/stop programs shall be applied to all regularly scheduled mechanical systems.

Demand limit/load shed programs shall be applied to all mechanical systems greater than 5-hp.

Trend log/historical data shall be implemented for every point on the system. Point trends shall be grouped into logically interrelated points for individual mechanical systems. Initial set-up shall be to log values once every 5-minutes.

B-OWS Graphics:

1. All sensors, control devices and set points shall be visible on a B-OWS in graphical form.
2. All mechanical systems shall have a programmed real time color graphic for primary graphical user interface. The only exception allowed will be unit heaters which require a tabular summary for the points associated with these systems.
3. Individual floor plan graphics will be programmed for each area of the building. All space sensors will be visible on floor plan graphics and system graphic.

The system shall observe the following command priorities (from highest to lowest):

1. Manual Operator Command.
2. Energy Management.
3. Automatic Control.

### 3.3 OPERATORS WORK STATION AND PORTABLE OPERATORS WORK STATIONS (B-OWS) HARDWARE

Assemble PC components in a configuration that allows easy operator access to all necessary components from one position. Locate components as required by the Owner, but at a minimum in a clean air-conditioned space separate from any mechanical equipment spaces.

Connect to LAN as required. If LAN/WAN is not dedicated to the BACnet internetwork the develop LAN/WAN System Architecture diagram denoting server B-OWS relative to other nodes on its segment of the LAN/WAN.

Provide sufficient RAM to meet system performance requirements.

### 3.4 PRINTERS

Set-up and connect printers as required.

Printer will only be accepted after demonstrating that the most complicated graphic prints with amount of RAM in printer.

### 3.5 SERVICE TOOL

Provide to Owner at time of acceptance. Do not use Service Tools for commissioning of the system.

### 3.6 LAN TYPES

The control system shall be configured so that any individual network shall not exceed 80-percent of its total design capacity. The system shall have a reserve of 20-percent point capacity.



Where possible all hubs, switches, half and full routers will be from the same manufacturer. Switches will be all "Store and Forward" type and will be installed in accordance with manufacturer specifications.

Inverted networks will not be allowed. Networks with minimum packet sizes smaller than those it connects to will not interconnect networks with larger minimum packet sizes. If three or more networks are interconnected the network with the highest speed and minimum packet size will be utilized to interconnect the slower networks.

Where BACnet/IP LAN type is used with non-IP devices tunneling routers shall be used to maintain complete connectivity. Where BACnet/IP is provided new then the hardware provided for the project will meet Addendum a to ANSI/ASHRAE 135-1995 BACnet/IP.

### 3.7 VERIFICATION SOFTWARE

Demonstrate exclusive communication utilizing the BACnet Protocol on all segments of the BACnet Internetwork.

### 3.8 BUILDING CONTROLLERS (B-BC)

Provide as required to meet performance requirements of the system with a 20-percent increase in connected B-AAC and B-ASC on any individual network.

Locate strategically such that B-BC locations are as equally distributed throughout the project as possible.

### 3.9 ADVANCED APPLICATION CONTROLLER (B-AAC)

Provide a dedicated B-AAC for each major mechanical system, such as chilled water plant, heating hot water plant, for each AHU system, pool heating water system, etc.

All points used for a single mechanical system shall be connected to the same B-AAC. Points used for control loop reset based on outside air, or space/zone temperature, or extremely remote differential pressure sensors on slow acting control loops are exempt from this requirement.

Provide minimum of 15-percent spare I/O point capacity for each point type found at each B-AAC. If input points are not universal, 15-percent of each type is required. A minimum of two spares are required for each type of point used. Future use of spare capacity shall require providing only the field device, field wiring, point database definition and custom software. Additional point modules may be required to implement use of these spare points.

### 3.10 APPLICATION SPECIFIC CONTROLLERS (B-ASC)

Provide a dedicated B-ASC for each Terminal Unit Mechanical Device on the project. Those include VAV terminal units, unit heaters and individual fans. Terminal units specifically called out in the sequence of operation as "Non-DDC" shall be excluded from this requirement.

All points used for a single Terminal Unit Mechanical Device shall be connected to a dedicated B-ASC. Points used for control loop reset based on outside air, or space/zone temperature, or extremely remote differential pressure sensors on slow acting control loops are exempt from this requirement.

VAV Terminal Unit Controllers:

1. Provide Networked System Controllers for each VAV terminal unit consisting of a B-ASC, damper actuator, velocity transducer and room temperature sensor.
2. The terminal unit manufacturer shall provide a transformer and factory wired to the B-ASC and other control devices such as actuators.
3. The terminal unit shall be provided with multi-point averaging type flow sensor factory piped to the velocity transducer.
4. Provide a space temperature sensor for each terminal unit that shall be field mounted and wired. Incorporate the plug-in connection for the Service Tool of Portable B-OWS.

3.11 LOCAL I/O

At a minimum the Portable B-OWS shall be able to connect to the BACnet Internetwork within each mechanical equipment space within the project. For manufacturers systems that do not allow direct portable B-OWS connections to B-AAC and B-ASC, this may require that a higher level LAN be routed to each mechanical equipment space with a jack.

3.12 CONTROL ENCLOSURES AND SUB-PANELS

All system components not designed for or required to be field installed shall be mounted in a control enclosure. Those components shall be sub-panel mounted except components that are mounted on the panel face. Provide on/off power switch with over-current protection for control power sources in each local enclosure.

All control enclosures shall be located so visual observation and adjustment can be accomplished while standing flat footed on the floor in a convenient location adjacent to the equipment served. Install all equipment in readily accessible location as defined by Chapter 1 Article 100 Part A of the NEC.

Label all control system components.

A copy of the "As-built" application engineering for the system served shall be laminated in clear plastic; be legible and temporarily suspended within enclosure.

All B-BC, B-AAC and B-ASC shall be mounted in an enclosure.

3.13 INTERCONNECTING WIRE AND CABLE

## General:

1. It shall be the System Contractor's responsibility to provide all wiring required for a complete Control System.
2. Control system wiring and cabling installed for this project shall include but may not be limited to the following:
  - a. Include all power wiring required not indicated on the electrical plans and specifications.
  - b. Power to all actuators and, where required, sensors.
  - c. Provide all wiring and cabling for network communications except for Owner provided LANs/WANs.
  - d. All sensor and control device input and output wiring.
  - e. All interconnecting cabling between and amongst network devices, PCs printers, modems, etc.
  - f. Interlock wiring between devices, and between motor starters.
  - g. All other necessary wiring for fully complete and functional system as specified.
  - h. Field mounting and wiring of control devices applicable to the Control System but specified elsewhere to be field installed by System Contractor including, but not limited to, wiring of unit heater thermostats.
3. Install piping, wiring/cabling parallel to building lines.
4. Maximum allowable voltage for control wiring shall be 120-volts.
5. All wiring shall be installed as continuous links, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.
6. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
7. This Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

## Power Wiring and Cabling:

1. If available, all power wiring for the entire control system shall be from spare circuits on emergency power panels. If available, at a minimum, only those enclosures serving mechanical equipment on emergency power shall be feed from spare circuits on emergency power panels.
2. Power wiring for all enclosures and equipment, including branch circuit wiring from circuit breaker panels shall be the responsibility of the System Contractor unless specifically shown on the Plans or Specifications to be provided under Division 16.
3. All B-OWS equipment shall be served from isolated ground receptacles via UPS by dedicated branch circuits.

4. All other enclosures, sensor and control devices shall be fed from separate circuits in the electrical distribution panels and shall not be served from the typical floor receptacle or lighting circuits.

Network Wiring and Cabling:

1. Network installation shall conform to standards for the LAN types and cabling types selected. Specific network rules inherent to the ANSI/ASHRAE Standard 135-1995, BACnet will be followed. Those include but are not limited to:

- a. Only one path can exist from any BACnet device to another.
- b. Each BACnet device connected to an internetwork LAN must have a unique device instance (0-4,194,303).
- c. each internetwork LAN must have a unique Network Number (1-65,545).

2. Primary LAN Network wire and cable shall be run in metallic conduit separately from all other wiring.

3. Other LAN Network wire and cabling shall be installed separate from any wiring over 30-volts.

4. All communications shielding shall be grounded as per Networked System manufacturer's recommendations.

5. Contractor may elect to run unshielded cable if noise immunity is ensured by other means. Contractor will be fully responsible for noise immunity and rewire with shielded cable if electrical or RF noise affects performance.

Installation:

1. Except in mechanical and electrical spaces where other conduits or piping is exposed, conceal wiring and cabling as much as possible and install as follows:

- a. In Enclosures: Panduit.
- b. Exposed in mechanical spaces above 8-feet: In EMT (electric metallic tubing).
- c. Exposed in mechanical spaces below 8-feet. In EMT.
- d. LANs concealed above accessible ceilings: Cable.
- e. Other concealed above accessible ceilings: Cable.
- f. Above hard: In EMT.
- g. In hollow core partition walls: Cable.
- h. In block walls: In EMT.
- i. In poured concrete walls and deck: In EMT.
- j. Primary LAN: In EMT.
- k. In plenums: Rated Cable.
- l. Other network: Maintain noise immunity.
- m. Exposed above 8-feet in service areas: Cable.

3.14 ANALOG SENSOR

Temperature:

1. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other area affecting sensor readings.
2. Install and properly support all enclosures and sensing elements as much as possible in the center of duct cross section and in straight duct runs. In condensing environments use stainless steel flanges to support sensing elements.
3. Sensors mounted on air ducts having exterior insulation shall be provided with handy-box mounting with insulating material firmly fitted around hand-box.
4. Sensors for mixed air and air streams greater than 6 square feet or 24-inches in either direction shall be averaging type. Provide a minimum of 1 linear foot of sensor per 4 square feet of duct area or equal to duct width where installed, whichever is longer.
5. Temperature sensors installed in piping or tanks shall be in separable thermowells. Sensors shall be inserted into thermowells with conductive fluid. Assembly shall allow removal of sensor without loss of fluid.
6. At a minimum one outside air temperature sensor shall be installed. It shall be mounted outside on a northern exposure as high as serviceable on the building. The sensor shall be mounted within a ventilated enclosure meet to shield the sensor from the effects of the sun.
7. Terminal Unit Sensors shall be provided one per terminal unit device. They shall be wall mounted 60-inches above finished floor immediately inside of the door aligned with lighting switch. Where light switch is not representative of room conditions located thermostat on wall within room so it is capable of sensing true space conditions. Zone sensors shall have plain unmarked housings. Provide a minimum of 30-feet of temperature sensor control wiring for equipment with space sensor not located on the Drawings. In all areas where terminal unit sensor locations are not known at the time of building start-up, sensors shall be hung approximately 24-inches from the ceiling in the area of the controlled zone and connected. Control wiring shall be neatly coiled and attached to ceiling grid. Sensors located in service corridors where subject to regular damage shall be mounted 84-inches above finished floor.
8. Zone temperature sensors located on perimeter walls shall have insulated mounting bases to prevent false room temperature readings.
9. Where wall sensors are mounted in an area subject to damage provide suitable metal guard.
10. Where wall sensors are mounted in public spaces with adjustable

set points provide suitable security guard.

11. Provide matched temperature sensors for differential temperature measurement. Differential accuracy shall be within 0.1 degC (0.2 degF).

Humidity:

1. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other area affecting sensor readings.

2. Install and properly support all enclosures and sensing elements in a straight duct run as much in the center of duct cross section as possible. In condensing environments use stainless steel flanges to support sensing elements.

3. Mount adjacent to, symmetric and aligned with room sensors such that both can be serviced.

4. Protect room humidity same as temperature sensors.

Wet Bulb:

1. For outside air a mount same as outside air temperature sensor.

2. For duct mounting execute same as duct mounted temperature sensor.

Pressure:

1. Orient static pressure sensing tap directly down-stream in the airflow so as to eliminate velocity pressure effects. Locate pressure transducers within 50-feet of sensing point. Connect to sensors with tubing that prevents signal phase lag.

2. Water gauge taps shall include snubbers and isolation valve.

3. Water differential pressure sensors shall be piped through five-valve bypass assembly with snubbers.

4. Mount air differential pressure taps so that true differential is sensed.

Position: Mount damper position indicator onto damper blade and out of airstream as much as possible.

### 3.15 BINARY SENSORS (SWITCHES)

Temperature (freezestat):

1. Wherever mixed or entering air temperatures are below 37 degF (adj.), the sensing tube shall be installed across the leaving face of the preheat coils. The low-temperature thermostat shall be arranged to stop the units supply fan and its associated return air fan should the temperature at any point along the sensing element fall below 35 degF.

Provided a minimum of one foot of sensing element for each square foot of coil face area. In condensing environments use stainless steel sensing element and capillary mounting clips.

2. Provide a high limit thermostat for every air handling unit, supply fan, and exhaust fan, which is not otherwise protected by a smoke detector (refer to Division 16) and as required by Code.

#### Differential Pressure:

1. Differential pressure type switches shall be installed as per differential pressure sensors and shall provide a maximum switching differential of 10-percent of the sensed operating range for the application at minimum and maximum designed flow rates. Set point shall be selected to operate at midpoint of span.

2. Paddle type water flow switch shall be used verify flow through chiller, other applications for operational, safety or other critical control interlock, on-off flow status monitoring, and at locations as indicated on the Drawings. Provide with NEMA 4 enclosure when installed in a condensing environment.

3. Differential pressure type water flow switch shall only be used for on-off flow status monitoring of equipment. The sensing tubes shall be installed between the equipment and the nearest service valves.

Position: Mount damper blade end switch on damper blade as much out of the air stream as possible. End switch as installed shall be repeatable to within a range of 5-degrees.

Direct drive motors are permitted to utilize a current switch without an adjustable set point.

### 3.16 VALVES

Flow type for two-way valves shall be equal percentage, except for terminal unit zone valves, and differential pressure control applications. Flow type for three-way valves shall be linear, except for terminal unit zone and ball valves. Terminal unit zone and differential pressure applications shall be linear flow characteristic.

Two-way and three-way control valves shall be provided for all applications as shown on the control drawings.

Two-way valves shall not be placed on branch or main hydronic circuits where these valves will cause a "dead-head" pumping condition. Three-way valves shall be used to avoid this condition.

Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:

1. Two-way liquid valve bodies shall not be designed less than 125 psig or 150-percent of total system (pump) head, whichever is greater.

2. Three-way liquid valve bodies shall be 300-percent of pressure differential between ports A and B at design flow or 100-percent of total system (pump) head.

Water Sizing Criteria at Full Flow:

1. Two-position service shall be Line size.
2. Two-way or three-way modulating service shall have a pressure drop equal to 5 psi.
3. Differential pressure modulating service shall have a pressure drop equal to 15 psi.

### 3.17 VALVE ACTUATORS

When an air handling unit or major piece of mechanical equipment is not in operation, control devices shall remain in their "off" positions defined as follows:

Devices	"Off Position"
Heating Coil Valves:	Closed.
Cooling Coil Valves:	Closed.
Variable Frequency Drive:	Off.

### 3.18 DAMPER ACTUATORS

Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

Modulating actuators shall be provided except that terminal unit mechanical devices may use an actuator that responds to a floating or tri-state signal.

Minimum torque and power output requirements of actuators shall not be less than 1.2 times required design load.

When an air handling unit or major piece of mechanical equipment is not in operation, control damper shall remain in their "off" positions defined as follows:

Devices	"Off Position"
Outside Air Damper:	Closed.
Return Air Damper:	Open.
Exhaust/Relief Air Damper:	Closed.

### 3.19 COMMISSIONING PROCEDURES

#### 3.19.1 General Procedures

##### 3.19.1.1 Evaluations



The Contractor shall make the observations, adjustments, calibrations, measurements, and tests of the control systems, tune the controllers, set the time clock schedule, and make any necessary control-system corrections to ensure that the systems function as described in paragraph CONTROL SEQUENCES OF OPERATION. The Contractor shall permanently record, on system equipment schedule, the final setting of controller proportional, integral and derivative constant settings, set point, manual reset setting, maximum and minimum controller output, and ratio and bias settings, in units and terminology specific to the controller.

#### 3.19.1.2 Item Check

An item-by-item check of the sequence of operation requirement shall be performed using Steps 1 through 4 in the specified control system commissioning procedures. Steps 1, 2, and 3 shall be performed with the HVAC system shutdown; Step 4 shall be performed after the HVAC systems have been started. Signals used to change the mode of operation shall originate from the actual HVAC control device intended for the purpose, such as the time clock. External input signals to the HVAC control panel (such as EMCS, starter auxiliary contacts, and external systems) may be simulated in Steps 1, 2, and 3. With each operational-mode change signal, pilot lights and HVAC-panel output-relay contacts shall be observed to ensure that they function. All terminals assigned to EMCS shall be checked and observed to ensure that the proper signals are available.

#### 3.19.1.3 Weather-Dependent Test Procedures

Weather-dependent test procedures that cannot be performed by simulation shall be performed in the appropriate climatic season. When simulation is used, the Contractor shall verify the actual results in the appropriate season.

#### 3.19.1.4 Configuration

The Contractor shall configure each controller for its specified service.

#### 3.19.1.5 Two-Point Accuracy Check

A two-point accuracy check of the calibration of each HVAC-control-system sensing element and transmitter shall be performed by comparing the HVAC-control-panel readout to the actual value of the variable measured at the sensing element and transmitter or airflow measurement station location. Digital indicating test instruments shall be used, such as digital thermometers, motor-driven psychrometers, and tachometers. The test instruments shall be at least twice as accurate as the specified sensing element-to-controller readout accuracy. The calibration of the test instruments shall be traceable to NIST standards. The first check point shall be with the HVAC system in the shutdown condition, and the second check point shall be with the HVAC system in an operational condition. Calibration checks shall verify that the sensing element-to-controller readout accuracies at two points are within the specified product accuracy tolerances. If not, the device shall be recalibrated or replaced and the calibration check repeated.

#### 3.19.1.6 Insertion, Immersion Temperature

Insertion-temperature and immersion-temperature sensing element and transmitter-to-controller readout calibration accuracy shall be checked at one physical location along the axis of the sensing element.

#### 3.19.1.7 Averaging Temperature

Averaging-temperature sensing element and transmitter-to-controller readout calibration accuracy shall be checked every 2 feet along the axis of the sensing element in the proximity of the sensing element, for a maximum of 10 readings. These readings shall then be averaged.

#### 3.19.1.8 Controller Stations

The Contractor shall use the controllers' MANUAL/AUTOMATIC stations as the means of manipulating control devices, such as dampers and valves, to check IP operation and to effect stable conditions prior to making measurement checks.

#### 3.19.1.9 Controller-Tuning Procedure

The Contractor shall perform a controller-tuning procedure, which shall consist of setting the initial proportional, integral, and derivative (PID) mode constants, controller set points, and logging the settings. Tuning shall be self-tuning operation by the controller unless manual tuning is necessary.

#### 3.19.1.10 Controller Manual-Tuning Procedure

Where required, the controller manual-tuning procedure shall be performed in three steps. Using a constant-temperature-set point controller as an example, these steps are:

a. Step A:

(1) The controller MANUAL/AUTO station shall be indexed to the AUTO position and the integral- and derivative-mode constants set to zero.

(2) The proportional-mode constant shall be set to an initial setting of 8 percent. (This corresponds to 1.5 psig per degree F or 2.0 ma per degree F proportional controller output change for a 100 degree F transmitter span.) This causes the controller output signal to vary from live zero output to full output for an input signal change representing an 8 degree F change.

(3) Controllers for other variables, such as relative humidity and static pressure, shall have their proportional-mode constants set initially in a similar manner for an achievable output range proportional to the transmitter span.

b. Step B:

- (1) The controller temperature set point shall be set at any achievable temperature. The controller output and transmitter input shall be observed.
- (2) If the transmitter input continuously oscillates above and below the set point without settling at a fixed value, or if such oscillation increases, the proportional-mode constant is too small.
- (3) If the proportional-mode constant is too small, increase it in steps until the transmitter input indicates stable control at any temperature, provided that the controller output is not at either extreme of the output range.
- (4) If the temperature control point slowly drifts toward or away from the controller set point, the proportional-mode constant is too large. Its setting shall be decreased in steps until oscillations occur as described in the preceding paragraphs, and then the setting shall be increased until stable control occurs.
- (5) A step change in controller set point shall be introduced. This should cause the controller to overshoot the set point slightly, with each subsequent overshoot peak value decreasing by a factor of 2/3 until stable control is achieved at, above, or below the set point.
- (6) Next, the integral-mode constant setting shall be increased in small steps, and set point changes shall be introduced until control point and controller set point coincide at stable control. This should happen consistently after a set point change within a short time, such as 5 to 10 minutes.

c. Step C:

- (1) Unless the HVAC process variable changes rapidly, the derivative-mode constant setting can remain at zero.
- (2) If derivative control is needed, the derivative-mode constant shall be gradually increased.
- (3) Step changes in controller set point shall be introduced, and the derivative-mode constant setting adjusted until stable control is achieved.

3.19.1.11 Setting the Controller

After the controller manual-tuning procedure is complete, the controller shall be set at the set point as shown.

3.19.2 Unit Heater and Cabinet Unit Heater

The "OFF/AUTO" switch shall be placed in the "OFF" position. Each space-thermostat temperature setting shall be turned up so that it makes contact to turn on the unit-heater fans. The unit-heater fans shall not

start. The "OFF/AUTO" switch shall be placed in the "AUTO" position. The unit-heater fans shall start. Each space-thermostat temperature setting shall be turned down, and the unit-heater fans shall stop. The thermostats shall be set at their temperature set points shown. The results of testing of one of each type of unit shall be logged.

### 3.19.3 All-Air Small Packaged Unitary

The schedules shall be manually entered for day-temperature and night-temperature set points as shown. The fan "AUTO/ON" switch shall be set to "ON". The time shall be manually entered as "DAY". The heating-cooling switch shall be raised to "HEATING" and cooling shall be off. The temperature set point shall be raised and heating shall start. The heating-cooling switch shall be set to "COOLING" and heat shall be off. The temperature set point shall be lowered and cooling shall start. The fan "AUTO/ON" switch shall be set to "AUTO" and the foregoing procedure repeated. The fan shall start and stop automatically with the starting and stopping of heating and cooling. The time shall be manually entered as "NIGHT". The foregoing procedures shall be repeated. When the system is verified as operational, the correct "DAY" and "NIGHT" temperature settings shall be restored and the correct time restored. The power to the thermostat shall be shut off and it shall be verified that the thermostat clock keeps time. The results of testing of one of each type of unit shall be logged.

### 3.19.4 Single Building Hydronic-Heating with Hot Water Boiler

Steps for installation shall be as follows:

- a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. It shall be verified that power and main air are available at the HVAC system control panel.
- b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature-sensing element location. Each controller display shall be read, and the thermometer and controller-display readings logged. The calibration accuracy of the sensing element-to-controller readout for outside-air temperature and system-supply temperature shall be checked.
- c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator using the controller "MANUAL/AUTO" station in "MANUAL." The proper operation of the actuators and positioners for all valves shall be verified visually. The signal shall be varied from live zero of 4 ma to 20 ma, and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other. Example: NC actuators are closed at 4 ma and are open at 20 ma . The signal levels that move the controlled device to its extreme positions shall be logged.

d. Step 4 - Control-System Commissioning:

(1) The outside-air temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position and the two-point calibration sensing element-to-controller readout accuracy check for the outside-air temperature performed. The controller proportional band adjustment, the set point, the manual reset, and the maximum controller output shall be set to achieve the outside-air temperature schedule shown.

(2) A signal shall be applied to simulate that the outside-air temperature is above the set point shown. It shall be verified that pumps and boiler stop. A signal shall be applied to simulate that the outside-air temperature is below the set point shown. It shall be verified that pumps start and boiler operates.

(3) The system's supply-temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the two-point calibration accuracy check of the sensing element-to-controller readout for the system-supply temperature performed. The controller shall be placed in the remote-set point mode. The remote set point for temperature schedule shall be set as shown. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller setup and tuning procedures performed. The controller shall be set at a system-supply temperature set point within the schedule as shown and the mode-constant set points logged. Signals of 8 ma and 16 ma shall be sent to the remote set point from the outside-air temperature controller, to verify that the controller set point changes to the appropriate values. The outside-air temperature controller's "MANUAL/AUTO" station shall be indexed to "AUTO."

(4) An occupied-mode signal shall be applied. Each space-temperature controller "MANUAL/AUTO" station shall be indexed to "MANUAL." The calibration accuracy check of sensing element-to-controller readout for each space temperature shall be performed, and the values logged. The controller shall be placed in the remote-set point mode. The set point low-end limit shall be set to 66 degrees F and the high-end limit shall be set to 72 degrees F. The proper action of the temperature-set point device at the space-temperature sensing element and transmitter location shall be verified. Each controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position and the controller-tuning procedure performed. An unoccupied-mode signal shall be applied and it shall be verified that each controller's set point changes to the unoccupied-mode setting. The temperature set point device shall be set to the space-temperature set point shown.

3.19.5 Heating and Ventilating

Steps for installation are as follows:

a. Step 1 - System Inspection: The HVAC system shall be observed in

its shutdown condition. Power and main air shall be available at the HVAC system control panel. The outside-air damper and relief-air damper shall be closed and the return-air damper shall be open.

- b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature-sensing element location. Each controller display shall be read, and the thermometer and controller-display readings logged. The calibration accuracy of the sensing element-to-controller readout for space temperature shall be checked.
- c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, using the controller "MANUAL/AUTO" station in "MANUAL." The proper operation of the actuators and positioners for all dampers and valves shall be verified. The signal shall be varied from live zero of 4 ma to 20 ma, and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced and parallel-operated actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.
- d. Step 4 - Control-System Commissioning:
  - (1) With the fan ready to start, the ventilation-delay-mode signal shall be applied, and it shall be verified that the ventilation-delay-mode pilot light turns on. The occupied-mode signal shall be applied and it shall be verified that the occupied-mode pilot light turns on and that supply fan starts. It shall be verified that the outside-air and relief-air dampers are closed, the return-air damper is open, and the heating-coil valve is under control, by slightly changing the controller outputs. The ventilation-delay-mode signal shall be released, and it shall be verified that the ventilation-delay-mode pilot light turns off and that the outside-air, return-air, and relief-air dampers come under control by changing the controller output.
  - (2) The minimum-outside-air-mode signal shall be applied. It shall be verified that the outside-air damper opens to minimum position and the economizer pilot light is off.
  - (3) The space-temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the calibration accuracy check for sensing element-to-controller readout shall be performed. The controller shall be placed in the remote-set point mode. The set point low-end limit shall be set to 66 degrees F and the high-end limit shall be set to 72 degrees F. Proper operation of the temperature set point device at the space temperature sensing element and transmitter location shall be verified. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position and the controller-tuning procedure shall be performed. The temperature set point device shall be set to

the space temperature set point as shown.

(4) An unoccupied-mode signal shall be applied, and it shall be verified that the occupied-mode pilot light turns off, the HVAC system shuts down, and the control system assumes the specified shutdown conditions. The night-thermostat temperature setting shall be turned upward, and it shall be verified that the HVAC system starts; the setting shall be turned downward, and it shall be verified that the HVAC system stops. The night thermostat shall be set at the set point as shown.

(5) With the HVAC system running, a filter differential-pressure switch input signal shall be simulated, at the device. It shall be verified that the filter pilot light turns on, and that contact output at EMCS terminals is made. The differential-pressure switch shall be set at the set point as shown.

(6) With the HVAC system running, a freezestat trip input signal shall be simulated, at the device. HVAC system shutdown shall be observed. It shall be verified that the low-temperature pilot light turns on and that contact output at the EMCS terminals is made. The freezestat shall be set at the set point as shown. The HVAC shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

(7) With the HVAC system running, a smoke-detector trip input signal shall be simulated at each detector, and verification of control-device actions and interlock functions as described in paragraph CONTROL SEQUENCES OF OPERATION shall be made. Simulation shall be performed without false-alarms any Life Safety systems. It shall be verified that the HVAC system shuts down and that the smoke-detector pilot light turns on, and contact output at EMCS terminals shall be verified. The detectors shall be reset. The HVAC system shall be restarted by manual reset, and it shall be verified that the pilot light turns off.

#### 3.19.6 Variable Air Volume, Without Return Fan

Steps for installation shall be as follows:

- a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. Power and main air shall be available at the HVAC system control panel. The outside air and relief air dampers shall be closed, the return air damper open, and the supply fan inlet vanes and cooling coil valve shall be closed.
- b. Step 2 - Calibration Accuracy Check with HVAC System in Shutdown: Readings shall be taken with a digital thermometer at each temperature sensing element location. Each controller display shall be read, and the thermometer and controller display readings logged. The calibration accuracy of the sensing element-to-controller readout for outside air, return air, mixed air, and the cooling coil discharge air temperatures shall be checked. The minimum outside air flow shall be read, using a

digital indicating velometer, and the velometer and controller display readings logged. The flow shall read zero.

- c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, using the controller "MANUAL/AUTO" station in "MANUAL." The proper operation of the actuators and positioners for all dampers and valves shall be verified. The signal shall be varied from live zero of 4 ma to 20 ma, and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced and parallel-operated actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

- d. Step 4 - Control System Commissioning:

(1) With the fan ready to start, the ventilation delay mode signal shall be applied, and it shall be verified that the ventilation delay mode pilot light turns on. The occupied mode signal shall be applied, and it shall be verified that the occupied mode pilot light turns on and that supply fan starts. It shall be verified that the outside air and relief air dampers are closed, the return air damper is open, and the cooling coil valve and inlet vanes are under control, by slightly changing the controller output. The ventilation delay mode signal shall be released, and it shall be verified that the ventilation delay mode pilot light turns off and that the economizer outside air and relief air dampers remain closed, the return air damper remains open, and the minimum outside air damper comes under control of the minimum outside air flow controller, by changing the controller output.

(2) The 2-point calibration accuracy check of sensing element-to-controller readout for the minimum outside air flow measurement station shall be performed. VAV box dampers shall be forced to the full open position, exhaust fans turned off, the supply duct static pressure controller output manually adjusted to achieve the design duct static pressure, and manually adjust the minimum outside air flow controller output to achieve a flow which is approximately 25% less than the desired air flow. Under these conditions, the minimum outside air flow control loop shall be tuned. Stable operation of the minimum outside air flow control loop in response to a process disturbance shall be confirmed.

(3) With supply fan running, a high static pressure input signal shall be simulated at the device, by pressure input to the differential pressure switch sensing device. HVAC system shutdown shall be observed. It shall be verified that the high static pressure pilot light turns on, and that contact output at the EMCS terminals is made. The differential pressure switch shall be set at the set point shown. The HVAC system shall be restarted by manual restart, and it shall be verified that the high static pressure pilot light turns off.



(4) The supply fan static pressure controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the two-point calibration accuracy check for sensing element-to-controller readout shall be performed. The controller shall be placed in the local set point mode. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller tuning procedure performed. The controller shall be set at the static pressure set point shown, and the mode constants logged.

(5) The mixed air temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position. An economizer mode input signal shall be simulated and it shall be verified that the economizer mode pilot light turns on. The mixed air temperature controller output shall be changed to slightly open the economizer outside air damper and the second point of the two-point calibration accuracy check of sensing element-to-controller readout for outside air, return air, and mixed air temperatures shall be performed. The controller tuning procedure shall be performed. The mixed air temperature controller "MANUAL/AUTO" switch shall be indexed to the "AUTO" position. The mixed air temperature controller shall be placed in the local set point mode and set at the temperature set point shown.

(6) The cooling coil temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the calibration accuracy check of sensing element-to-controller readout shall be performed. The controller shall be placed in the local set point mode, and set at the temperature set point shown. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller tuning procedure performed.

(7) An unoccupied mode signal shall be applied, and it shall be verified that the occupied mode pilot light turns off, the HVAC system shuts down, and the control system assumes the specified shutdown conditions. The night thermostat temperature setting shall be turned upward, and it shall be verified that the HVAC system starts; the setting shall be turned downward, and it shall be verified that the HVAC system stops. The night thermostat shall be set at the set point shown.

(8) With the HVAC system running, a filter differential pressure switch input signal shall be simulated at the device. It shall be verified that the filter pilot light turns on, and that contact output at the EMCS terminals is made. The differential pressure switch shall be set at the set point shown.

(9) With the HVAC system running, a freezestat trip input signal shall be simulated at the device. HVAC system shutdown shall be observed. It shall be verified that the low temperature pilot light turns on, and that contact output at the EMCS terminals is made. The freezestat shall be set at the set point shown. The HVAC system shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

(10) With the HVAC system running, a smoke detector trip input signal shall be simulated at each detector, and control device actions and interlock functions, as described in paragraph CONTROL SEQUENCES OF OPERATION shall be verified. Simulation shall be performed without false-alarms any Life Safety systems. It shall be verified that the HVAC system shuts down and that the smoke detector pilot light turns on, and contact output at the EMCS terminals is made. The detectors shall be reset. The HVAC system shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

(11) Velocity set points for minimum and maximum flow and temperature set points for the heating/cooling dead band shall be set, for each VAV terminal unit. The actions of the controller, the operation of the damper, and the operation of heating shall be verified. It shall be verified that space temperature is maintained.

### 3.19.7 Variable Air Volume Control

Steps for installation of system with return fan shall be as follows:

- a. Step 1 - System Inspection: The HVAC system shall be observed in its shutdown condition. Power and main air shall be available at the HVAC system control panel. The outside air and relief air dampers shall be closed, the return air damper open, and the inlet vanes and cooling coil valve shall be closed.
- b. Step 2 - Calibration Accuracy Check with HVAC System Shutdown: Readings shall be taken with a digital thermometer at each temperature sensing element location. Each controller display shall be read, and the thermometer and controller display readings logged. The calibration accuracy of the sensing element-to-controller readout for outside air, return air, mixed air, and cooling coil discharge air temperatures shall be checked. The minimum outside air, supply air, and return air flows shall be read, using a digital indicating velometer, and the velometer and controller display readings logged. The flows shall read zero.
- c. Step 3 - Actuator Range Adjustments: A signal shall be applied to the actuator, using the controller "MANUAL/AUTO" station in "MANUAL." The proper operation of the actuators and positioners for all dampers and valves shall be verified. The signal shall be varied from live zero of 4 ma to 20 ma, and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. It shall be verified that all sequenced and parallel-operated actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.
- d. Step 4 - Control System Commissioning:
  - (1) With the fans ready to start, the ventilation delay mode

signal shall be applied, and it shall be verified that the ventilation delay mode pilot light turns on. The occupied mode signal shall be applied, and it shall be verified that the occupied mode pilot light turns on and that supply fan and return fan start. It shall be verified that the outside air and relief air dampers are closed, the return air damper is open, and the cooling coil valve and inlet vanes are under control, by slightly changing the controller output. The ventilation delay mode signal shall be released, and it shall be verified that the ventilation delay mode pilot light turns off and that the economizer outside air and relief air dampers remain closed, the return air damper remains open, and the minimum outside air damper comes under control of the minimum outside air flow controller, by changing the controller output.

(2) The 2-point calibration accuracy check of sensing element-to-controller readout for the minimum outside air flow measurement station shall be performed. VAV box dampers shall be forced to the full open position, exhaust fans shall be turned off, the supply duct static pressure controller output shall be manually adjusted to achieve the design duct static pressure, the return fan volume controller output shall be manually adjusted to achieve the design differential flow difference between the supply and return duct flows, the minimum outside air flow controller output shall be manually adjusted to achieve a flow which is approximately 25% less than the desired air flow. Under these conditions, the minimum outside air flow control loop shall be tuned. Stable operation of the minimum outside air flow control loop in response to a process disturbance shall be confirmed.

(3) With supply fan running, a high static pressure input signal shall be simulated at the device, by pressure input to the differential pressure switch sensing device. HVAC system shutdown shall be observed. It shall be verified that the high static pilot light turns on, and that contact output at the EMCS terminals is made. The differential pressure switch shall be set at the set point shown. The HVAC system shall be restarted by manual restart, and it shall be verified that the high static pressure pilot light turns off.

(4) The supply fan static pressure controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the two-point calibration accuracy check for sensing element-to-controller readout shall be performed. The controller shall be placed in the local set point mode. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller tuning procedure performed. The controller shall be set at the static pressure set point, and the mode constants logged.

(5) Each VAV terminal unit controller's minimum flow and maximum flow set points shall be set at the same setting, to prevent the VAV box damper from modulating under space temperature control and to achieve a constant supply duct system pressure drop. The

return fan inlet vane shall be placed under control, and the starter switch shall be turned to the "AUTO" position so that the fan starts. The "MANUAL/AUTO" station of the return fan air volume controller shall be indexed to the "MANUAL" position, and the two-point calibration accuracy check of sensing element-to-controller readout shall be performed. The controller shall be placed in the remote set point mode. Using the supply duct static pressure controller's "MANUAL" function, the supply fan inlet vane shall be operated to change the supply fan flow, and the controller ratio and bias settings shall be set to control at cfm at 4-ma input and cfm at 20-ma input. The supply fan flow shall be changed to verify that the return flow set point tracks the supply fan flow with the proper flow difference. A 12 ma signal shall be sent for tuning at set point midrange. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position and the controller tuning procedure shall be performed. A 4 ma, 12 ma and 20 ma signal shall be sent to the remote set point input, and it shall be verified that the return fan goes from minimum delivery set point to midrange delivery set point, and then to maximum delivery set point. The supply duct static pressure controller shall be placed in "AUTO."

(6) The mixed air temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position. An economizer mode input signal shall be simulated and it shall be verified that the economizer mode pilot light turns on. The mixed air temperature controller output shall be changed to slightly open the economizer outside air damper and the second point of the two-point calibration accuracy check of sensing element-to-controller readout for outside air, return air, and mixed air temperatures shall be performed. The controller tuning procedure shall be performed. The mixed air temperature controller "MANUAL/AUTO" switch shall be indexed to the "AUTO" position. The mixed air temperature controller shall be placed in the local set point mode and set at the temperature set point shown.

(7) The cooling coil temperature controller "MANUAL/AUTO" station shall be indexed to the "MANUAL" position, and the calibration accuracy check of sensing element-to-controller readout shall be performed. The controller shall be placed in the local set point mode, and set at the temperature set point shown. The controller "MANUAL/AUTO" station shall be indexed to the "AUTO" position, and the controller tuning procedure performed.

(8) An unoccupied mode signal shall be applied, and it shall be verified that the occupied mode pilot light turns off, the HVAC system shuts down, and the control system assumes the specified shutdown conditions. The night thermostat temperature setting shall be turned upward, and it shall be verified that the HVAC system starts; the setting shall be turned downward, and it shall be verified that the HVAC system stops. The night thermostat shall be set at the set point shown.

(9) With the HVAC system running, a filter differential pressure

switch input signal shall be simulated at the device. It shall be verified that the filter pilot light turns on, and that contact output at the EMCS terminals is made. The differential pressure switch shall be set at the set point shown.

(10) With the HVAC system running, a freezestat trip input signal shall be simulated at the device. HVAC system shall shut down, and contact output at EMCS terminals shall be verified. It shall be verified that the low temperature pilot light turns on. The freezestat shall be set at the set point shown. The HVAC system shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

(11) With the HVAC system running, a smoke detector trip input signal shall be simulated at each detector and control device actions and interlock functions, as described in paragraph CONTROL SEQUENCES OF OPERATION shall be verified. Simulation shall be performed without false-alarming any Life Safety systems. It shall be verified that the HVAC system shuts down, that the smoke detector pilot light turns on, and that contact output at the EMCS terminals is made. The detectors shall be reset. The HVAC system shall be restarted by manual restart, and it shall be verified that the pilot light turns off.

(12) For each VAV terminal unit, velocity set points shall be set for minimum and maximum flow, and temperature set points shall be set for the heating/cooling dead band. The actions of the controller, the operation of the damper, and the operation of heating shall be verified. It shall be verified that space temperature is maintained.

### 3.20 BALANCING, COMMISSIONING, AND TESTING

#### 3.20.1 Coordination with HVAC System Balancing

Commissioning of the control system, except for tuning of controllers, shall be performed prior to or simultaneous with HVAC system balancing. The Contractor shall tune the HVAC control system after all air-system and hydronic-system balancing has been completed, minimum damper positions set and a report has been issued.

#### 3.20.2 Control System Calibration, Adjustments, and Commissioning

Control system commissioning shall be performed for each HVAC system, using test plans and procedures previously approved by the Government. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform commissioning and testing of the HVAC control system. All instrumentation and controls shall be calibrated and the specified accuracy shall be verified using test equipment with calibration traceable to NIST standards. Wiring shall be tested for continuity and for ground, open, and short circuits. Tubing systems shall be tested for leaks. Mechanical control devices shall be adjusted to operate as specified. HVAC control panels shall be pretested off-site as a functioning assembly ready for field connections, calibration, adjustment,

and commissioning of the operational HVAC control system. Written notification of any planned commissioning or testing of the HVAC Control systems shall be given to the Government at least 14 calendar days in advance.

#### 3.20.3 Performance Verification Test

The Contractor shall demonstrate compliance of the HVAC control system with the contract documents. Using test plans and procedures previously approved by the Government, the Contractor shall demonstrate all physical and functional requirements of the project. The performance verification test shall show, step-by-step, the actions and results demonstrating that the control systems perform in accordance with the sequences of operation. The performance verification test shall not be started until after receipt by the Contractor of written permission by the Government, based on Government approval of the commissioning report and completion of balancing. The tests shall not be conducted during scheduled seasonal off-periods of base heating and cooling systems.

#### 3.20.4 Posted and Panel Instructions

Posted and panel instructions, showing the final installed conditions, shall be provided for each system. The posted instructions shall consist of half-size laminated drawings and shall include the control system schematic, equipment schedule, ladder diagram, sequence of operation, panel arrangement drawings, wiring diagram, and valve and damper schedules. The posted instructions shall be permanently affixed, by mechanical means, to a wall near the control panel. Panel instructions shall consist of laminated letter-size sheets and shall include a routine maintenance checklist and controller configuration check sheets with final configuration record for each controller. Panel instructions and one copy of the operation and maintenance manuals, previously described herein, shall be placed inside each control panel.

### 3.21 TRAINING

#### 3.21.1 Training-Course Requirements

A training course shall be conducted for operating staff members designated by the Contracting Officer. The training period, for a total of 32 hours of normal working time, shall be conducted within 30 days after successful completion of the performance verification test. The training course shall be conducted at the project site. Audiovisual equipment and sets of all other training materials and supplies shall be provided. A training day is defined as 8 hours of classroom instruction, including two 15-minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility.

#### 3.21.2 Training-Course Content

For guidance in planning the required instruction, the Contractor shall assume that attendees will have a high school education or equivalent, and are familiar with HVAC systems. The training course shall cover all of the material contained in the operating and maintenance instructions, the

layout and location of each HVAC control panel, the layout of one of each type of unitary equipment and the locations of each, the location of each system-control device external to the panels, the location of the compressed-air station, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, and repair procedures. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system. The results of the performance verification test and the calibration, adjustment and commissioning report shall be presented as benchmarks of HVAC control-system performance by which to measure operation and maintenance effectiveness.

### 3.22 SEQUENCES OF OPERATION

#### 3.22.1 General

The sequence of operations indicated illustrates basic control functions only. The type of control system specified in a sequence, in the schedule of point descriptions and on the drawings shall be supplied without exception. The system contractor shall be responsible to provide all necessary equipment, hardware, software, and programming to achieve the specified sequences of operation. However, control sequences shall not be limited to the point schedules and sequences of operation. It shall be the responsibility of the system contractor to review the drawings and applicable specifications to determine complete project requirements for sequences of operations and points to be monitored.

All the controls that are called for under sequences described below, shall be accomplished through the EMCS system.

#### 3.22.2 Building Condenser Water Closed Loop System Operation

##### General:

1. The building condenser water closed loop system, or WSHP loop, supplies condenser water to the heat pumps and energy recovery units (ERUs).
2. The WSHP system consist of:
  - a. Two variable water flow pumps (P-5 and P-6) operating in parallel (lead, lag and stand-by) and distributing condenser water to various water source heat pumps (HPs, RTUs) and energy recovery units (ERUs).
  - b. Two frame and plate exchangers.

##### Operation:

1. General: The temperature of the water in this loop shall be maintained between 65 degF (adj.) and 85 degF (adj.). Whenever the temperature in the closed loop is in this range, there will be no heating addition from the boilers or heat rejection from the cooling towers.

2. Start Up: Whenever there is call for heating or cooling from any of the water source equipment, according to local control sequences, BICS shall activate WSHP system. The WSHP system shall also be able to be activated manually, by signal from B-OWS (or B-POWS). System shall be activated in following sequence:

a. Lead pump (either P-5 or P-6) shall start at its lowest rpm (adj.) and circulate in closed loop across the water piping system. If the lead pump is commanded to start and fails to do so after a short time delay, the B-C controller will automatically start the lag pump and BICS shall send alarm signal to B-OWS.

3. Pump Control:

a. When demand increases or decreases, the two-position control valves located on the various water source equipment will open or close, causing the WSHP water system pressure vary. In that event B-BC controller will receive input from differential pressure sensor(s) and will slowly increase or decrease lead pump rpm via VFD to maintain differential pressure set point.

b. BICS system shall utilize software to optimize pumps energy consumption. Stage pumps on/off and modulate pumps speed to achieve their maximum performance based on pumps curves.

c. Under normal operation, the selection of the lead, lag and standby pump will be automatically alternated every 7-days (adj.).

4. Safeties and Maintenance: High and low temperature limits: When water temperature sensor installed in WSHP supply main detect cooling tower water supply temperature is outside low and high limits, initially set at 57 degF (adj.) and 100 degF (adj.) respectively, BICS shall send alarm signal to B-OWS.

### 3.22.3 Closed Circuit Cooling Tower Glycol System

#### General

1. The Closed Circuit Cooling Tower Glycol System (CTS) rejects heat from WSHP system.

2. The closed circuit cooling tower system consist of:

a. Three variable airflow, closed circuit cooling towers (CT-1, CT-2 and CT-3) operating in parallel (lead and lag).

b. Four constant flow glycol pumps (P-1, P-2, P-3 and P-4) operating in parallel (lead, lag and stand-by) and circulating condenser water between closed loop cooling towers and WSHP system via frame and plate heat exchanger.

c. Completely integrated Cooling Tower Management System (CTMS) provided by cooling towers' manufacturer interfaced with BACnet Internetworked Control System (BICS).

#### Operation:

1. Start-Up: When the temperature in the Building Condenser Water



Closed Loop System (WSHP) rises above it's reset cooling set point 85 degF (adj.), BICS shall send signal to CTMS to activate closed loop cooling tower system. The CTS shall also be able to be activated manually, either directly from CTMS or by signal from B-OWS (or B-POWS) to CTMS. System shall be activated in following sequence:

- a. Shut-off motorized valve on lead cooling tower glycol inlet (either CT-1, CT-2 or CT-3) shall fully open.
  - b. Lead pump (either P-1, P-2, P-3 or P-4) shall start and circulate glycol in closed loop across the CTS. If the lead pump is commanded to start and fails to do so after a short time delay, the BICS controller will automatically start the lag pump and alarm signal to B-OWS.
  - c. When demand for cooling in WSHP system increases second and third cooling towers shall start in the same sequence. At 90 degF condenser water temperature in WASHP system CTS shall operate at full capacity, three CTS pumps shall be energized, VFDs shall modulate towers fans on all cooling towers to there maximum speed; spray pumps on each cooling tower shall be energized.
2. CTS Optimization:
  - a. CTMS shall utilize software to optimize CTS energy efficiency while maintaining water temperature in WSHP between 85 degF and 90 degF.
  - b. CTS optimization shall include but not limited to: modulation towers fan speed; starting and stopping towers circulating spray pumps; alternating lead/lag cooling towers and CTS pumps every 7 days (adj.) under normal operation.
3. Basin heater control: When the water temperature in the tower basin drops below 40 degF, the basin heater shall be energized and operate to maintain the basin temperature no lower than 40 degF.
4. Basin water quality control: Bleed and feed conductivity controller shall send signal to BICS to monitor TDS (total dissolved solids) level.
5. Safeties and Maintenance:
  - a. High and low temperature limits: When any of the glycol temperature sensors installed on each cooling tower inlet and cooling supply main detect glycol supply temperature is outside low and high limits, initially set at 40 degF (adj.) and 90 degF (adj.) respectively, BICS shall send alarm signal to B-OWS.
  - b. Basin water level low limit: When electronic level sensor detects that tower basin water level drops below its acceptable limit, it shall de-energize basin water heater and BICS shall send alarm to B-OWS.
  - c. Basin water level high limit: When electronic level sensor detects that tower basin water level rises above its acceptable limit, BICS shall send alarm to B-OWS.
  - d. Power failure: Upon resumption of power, CTMS shall command a shutdown sequence immediately followed by a normal start-up sequence.

- e. Make-up water bleed valve: Flow switch installed on each cooling tower make-up water inlet BICS shall send alarm to B-OWS, if solenoid bleed valve get stuck on open position.
- f. Tower fans: CTMS shall allowed to run tower fans only in those towers with isolation valve open.

#### 3.22.4 Heat Injection Via Close Loop Hot Water Boiler System (HWBS)

##### General:

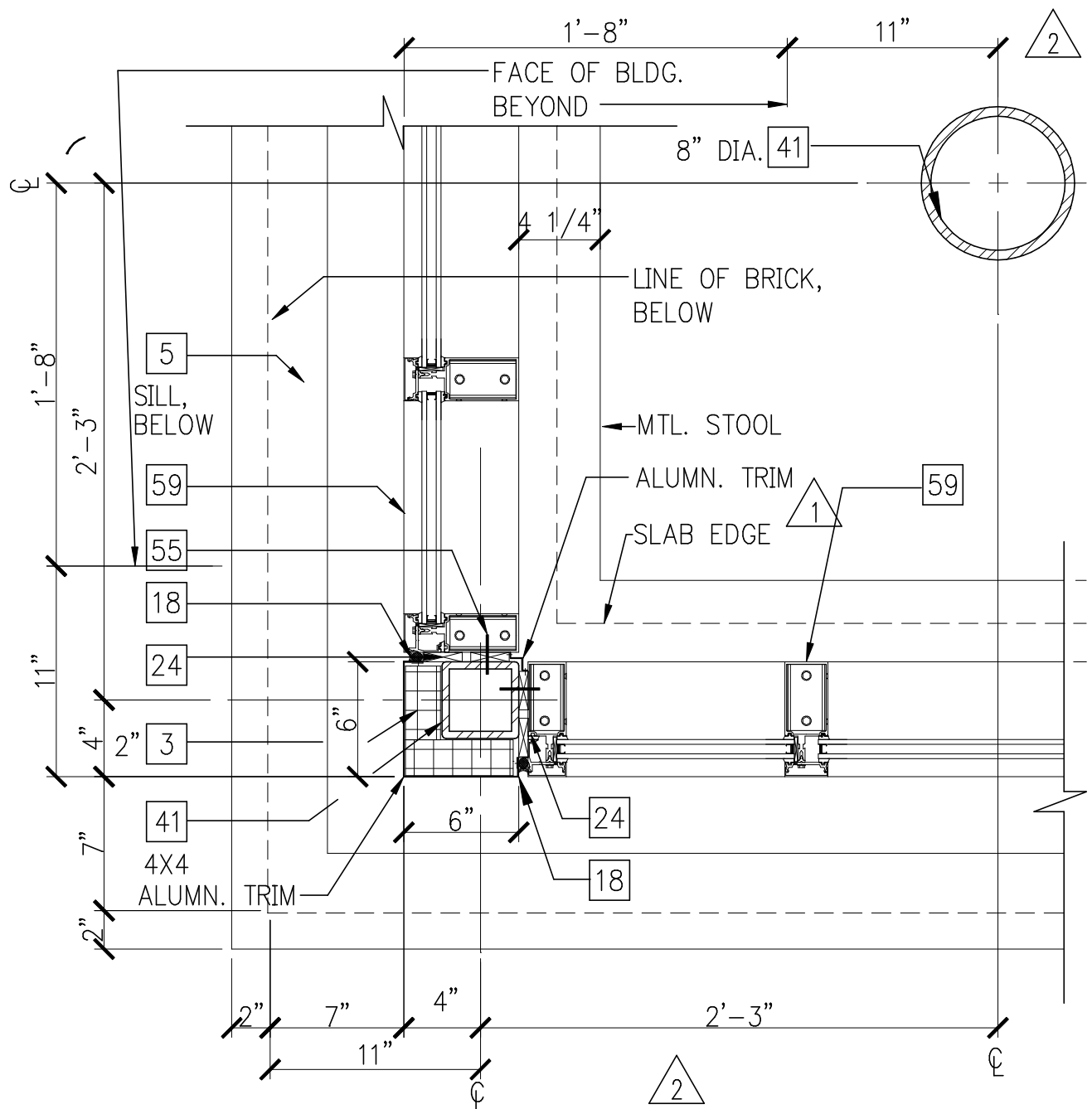
1. The Close Loop Hot Water Boiler System (HWBS) injects heat to WSHP system.
2. The HWBS consist of:
  - a. Three cast iron, gas fired hot water boilers (B-1, B-2 and B-3) operating in parallel (lead and lag).
  - b. Four constant water flow pumps (P-1, P-2, P-3 and P-4) operating in parallel (lead, lag and stand-by) and circulating hot water between hot water heating boilers and WSHP system via frame and plate heat exchanger.

##### Operation:

1. Start-up: When the temperature in the Building Condenser Water Closed Loop System (WSHP) drops below it's reset heating set point 65 degF (adj.), BICS shall activate closed loop hot water boiler system (HWBS). The HWBS shall also be able to be activated manually, by signal from B-OWS (or B-POWS). System shall be activated in following sequence:
  - a. Shut-off motorized valve on lead hot water boiler water inlet (either B-1, B-2 or B-3) shall fully open.
  - b. Lead pump (either P-7, P-8, P-9 or P-10) shall start and circulate in closed loop across the HWBS. If the lead pump is commanded to start and fails to do so after a short time delay, the B-C will automatically start the lag pump and send alarm signal to B-OWS.
  - c. Lead hot water boiler (either B-1, B-2 or B-3) shall energize in accordance with boiler's manufacturer start up sequence. If the lead boiler is commanded to start and fails to do so after a short time delay, the B-C will automatically start the lag boiler and send alarm signal to B-OWS.
  - d. When demand for heating in WSHP system increases second and third boilers shall start in the same sequence. At 60 degF condenser water temperature in WSHP system HWBS shall operate at full capacity, three boilers and three hot water pumps shall be energized.
2. Safeties and Maintenance: BICS shall be able interpret and send signals for all alarms generated by boiler's controller (provided by boiler's manufacturer) as described in Section 15569 to B-OWS.

#### 3.22.5 Summary

Condenser Water Closed Loop System (WSHP) Temperature (Adj.)	Control Action
57	Alarm.
60	Close loop hot water boiler system (HWBS) shall operate in full capacity.
60 to 65	Start close loop hot water boiler system (HWBS) in sequence as temperature in WSHP drops.
65 to 85	Normal operating range. CTS and HWBS shall be de-energized.
85 to 90	Start cooling tower closed glycol loop (CTS) in sequence as temperature in WSHP rises.
90	Cooling tower closed glycol loop (CTS) shall operate in full capacity.
105	Alarm.
-- End of Section --	



2 AMENDMENT NO. 3, ISSUED 05/12/2003

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Project:

NEVAL THOMAS ELEM. SCHOOL  
650 ANACOSTIA AVE., NE  
WASHINGTON, DC 20019  
CORNER DETAIL AT CONF.  
RM./CAFE

Project No.: 2001016.00

Designed by: EJ

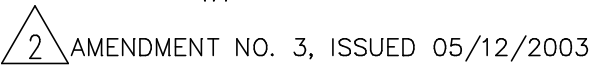
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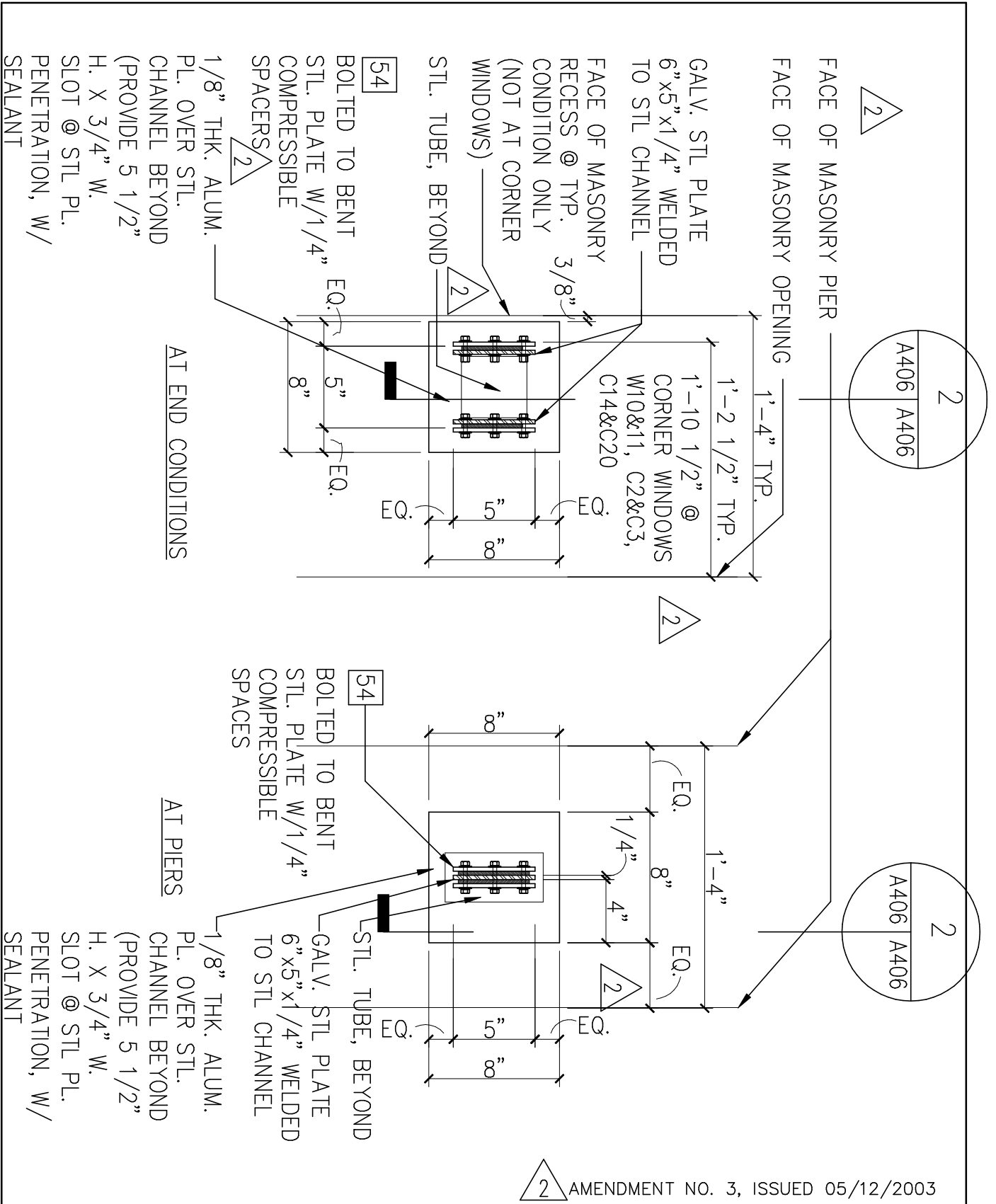
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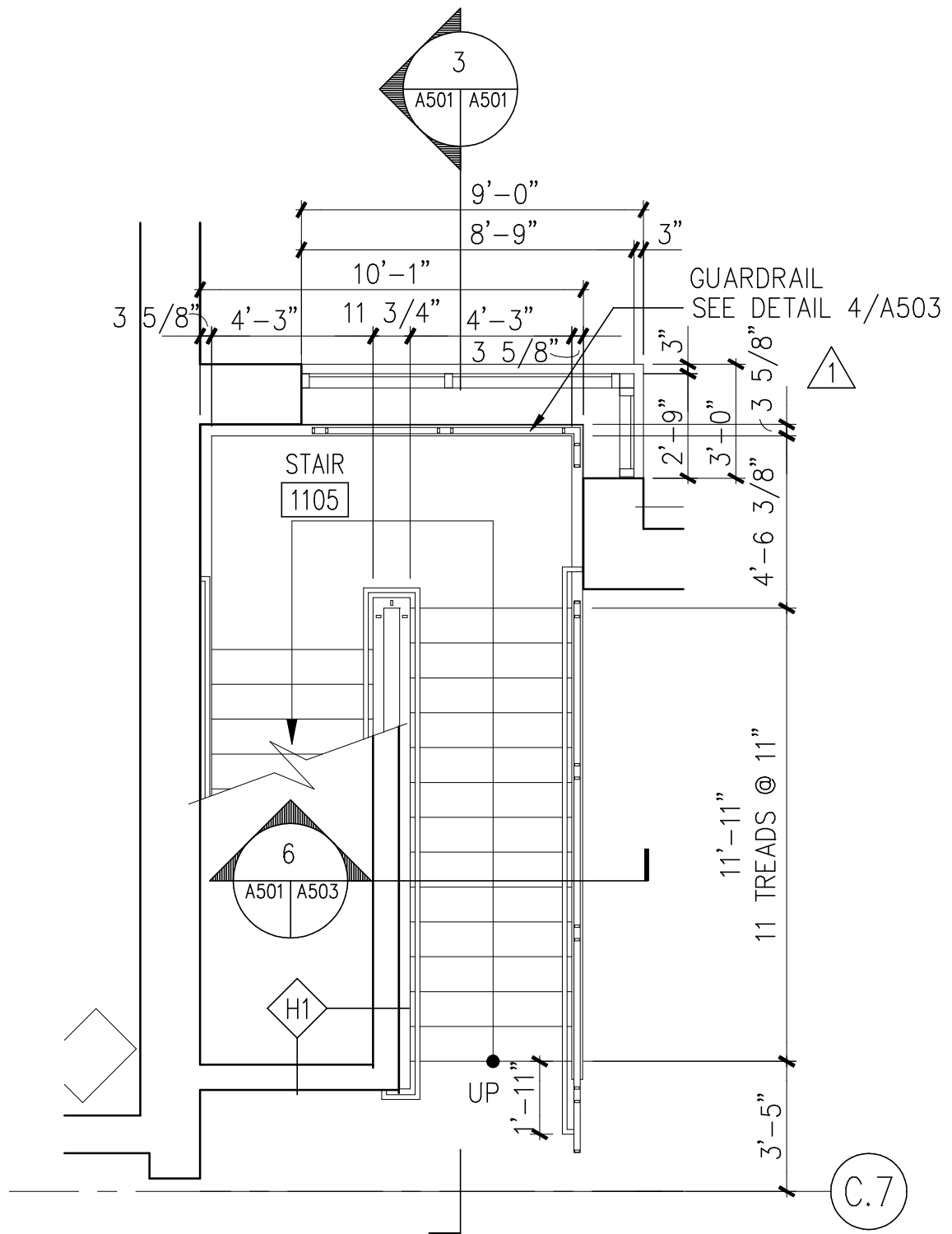
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Drawing No.: ADD-A-09

Modifies Drawing No.: 7/A404

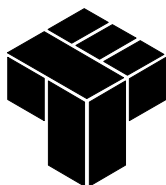






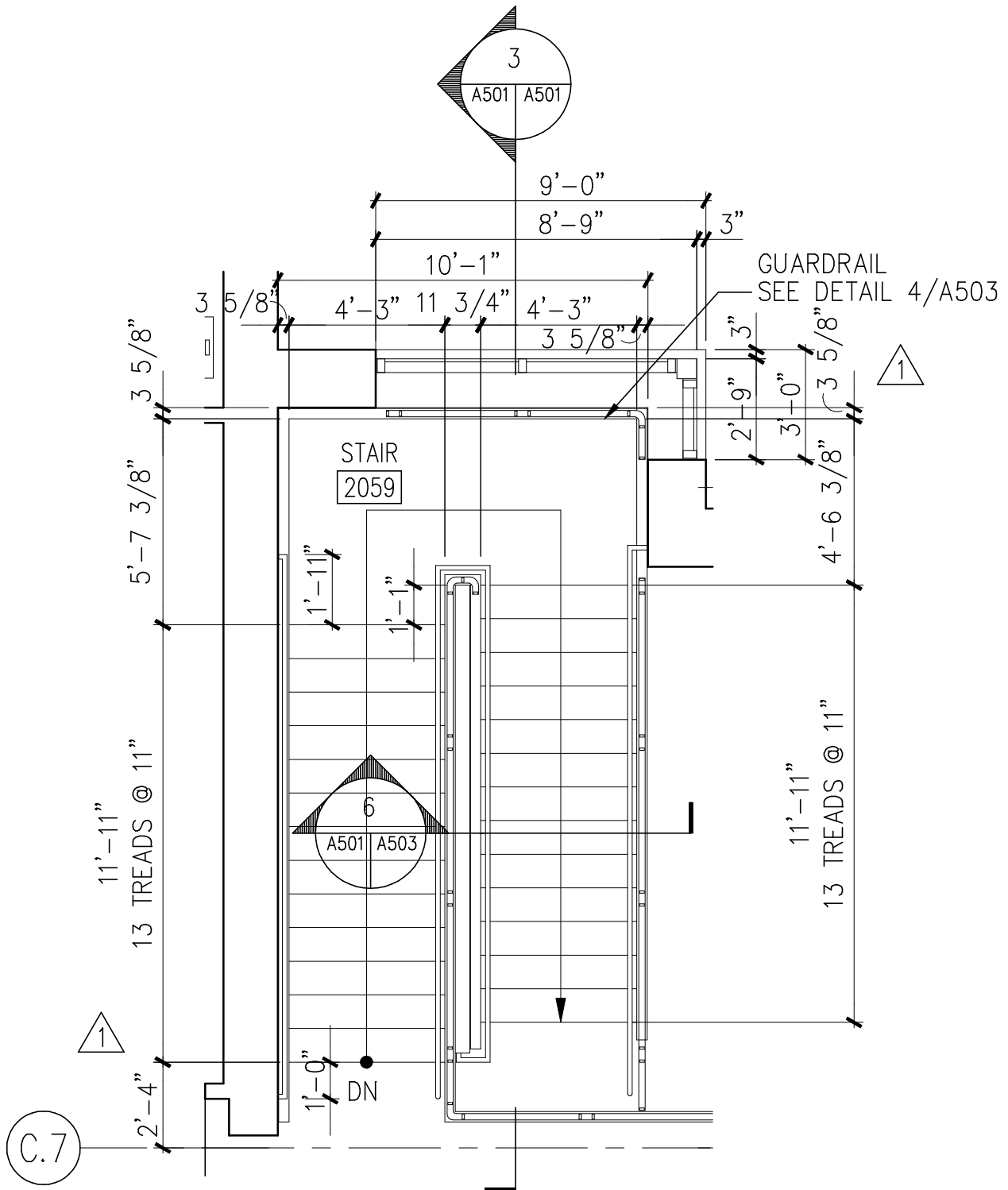
1 AMENDMENT NO. 3, ISSUED 05/12/2003

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Project: NEVAL THOMAS ELEM. SCHOOL Project No.: 2001016.00  
650 ANACOSTIA AVE., NE Designed by: EJ  
WASHINGTON, DC 20019 Drawn by: DC  
Title: LOBBY STAIR LEVEL ONE Checked by: SML  
Date: 05/12/2003  
Modifies Drawing No.: 6/A501 Drawing No.: ADD-A-12



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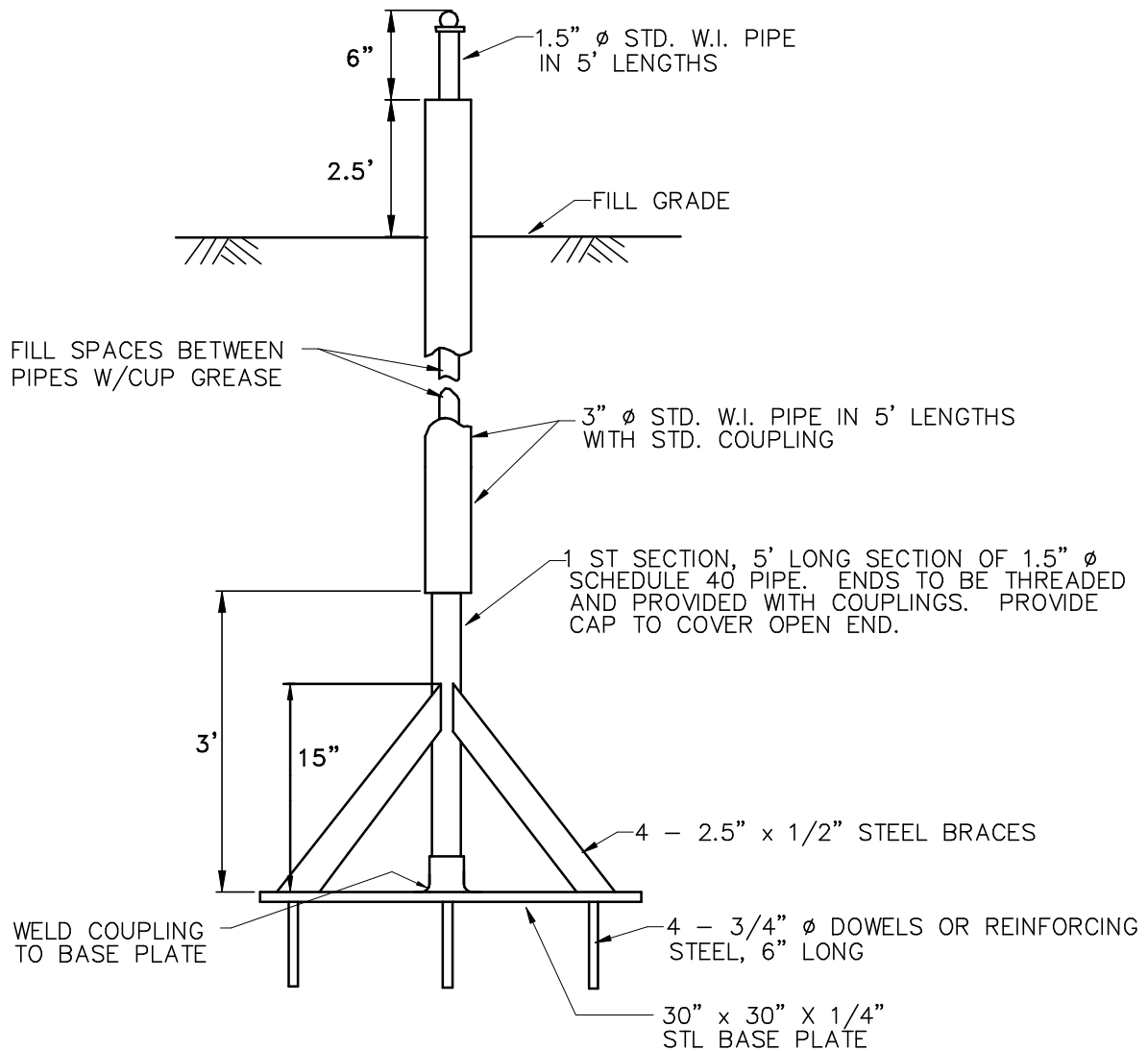
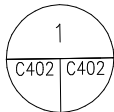


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Project: NEVAL THOMAS ELEM. SCHOOL Project No.: 2001016.00  
650 ANACOSTIA AVE., NE Designed by: EJ  
WASHINGTON, DC 20019 Drawn by: DC  
Title: LOBBY STAIR LEVEL TWO PLAN Checked by: SML  
Date: 05/12/2003  
Modifies Drawing No.: 9/A501 Drawing No.: ADD-A-13

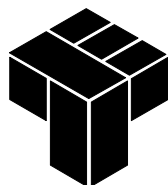


ALL CONNECTIONS OF BRACES  
AND DOWELS TO BE FULLY WELDED

A triangle with the number 1 inside.

SCALE: NOT TO SCALE

1 AMENDMENT NO. 3, ISSUED 05/12/2003

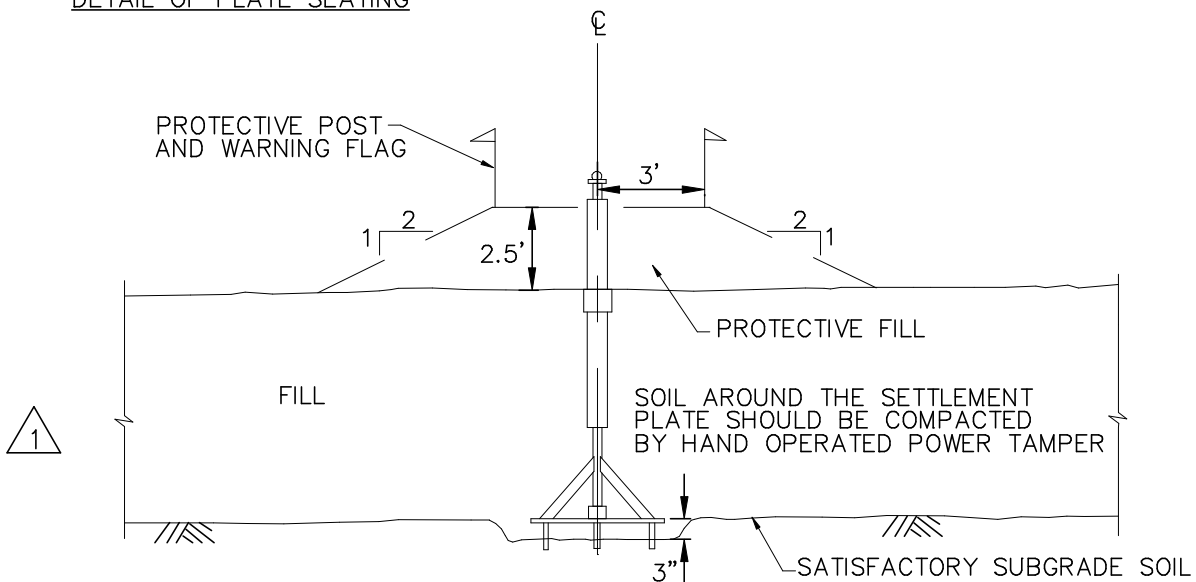




# INSTALLATION OF SETTLEMENT PLATE NOTES:

1. CLEARING AND STRIPPING OPERATIONS OF SUBGRADE SHALL BE COMPLETED AS INDICATED IN THE DRAWINGS AND SPECIFICATIONS.
2. IMMEDIATELY PRIOR TO PLACEMENT OF FILL, INSTALL THE SETTLEMENT PLATES AS SHOWN ON THE DETAILS. THE PLATES SHALL BE LOCATED AS INDICATED ON THE PLANS.
3. CONSTRUCT THE FILL IN ACCORDANCE WITH THE DRAWINGS AND SPECIFICATIONS. WITHIN A RADIUS OF 6 FEET AROUND THE CENTER OF THE SETTLEMENT PLATE, COMPACT THE SOIL BY HAND-OPERATED POWER EQUIPMENT. THIS PROTECTIVE FILL MUST BE CONSTRUCTED TWO LIFTS (TOTAL 16 INCH LOOSE THICKNESS) AHEAD OF THE MASS FILL OPERATION.
4. THE CONTRACTOR SHALL CONDUCT HIS OPERATION IN SUCH A MANNER THAT THE SETTLEMENT PLATES WILL NOT BE DAMAGED. SUITABLE SAFETY FLAGGING SHALL BE PLACED AROUND THE PLATES FOR THE DURATION OF THE PROJECT. ANY PLATES DAMAGED OR DESTROYED DUE TO FAULT OR NEGLIGENCE ON THE PART OF THE CONTRACTOR SHALL BE RESTORED OR REPLACED BY THE CONTRACTOR AT NO ADDITIONAL COST TO THE GOVERNMENT AS DIRECTED BY THE CONTRACTING OFFICER.
5. THE CONTRACTOR SHALL SURVEY THE TOP OF THE SETTLEMENT PLATE PIPES TO THE NEAREST TENTH OF AN INCH BOTH UPON INITIAL PLACEMENT AND WEEKLY THEREAFTER UNTIL 4 MONTHS AFTER COMPLETION OF THE FILL. THE CONTRACTOR SHALL PROVIDE THE SURVEY DATA TO THE CONTRACTING OFFICER WITHIN 3 DAYS AFTER EACH SURVEY. THE CONTRACTING OFFICER'S ENGINEER WILL EVALUATE THE SURVEY DATA TO DETERMINE WHEN SETTLEMENTS HAVE CEASED.
6. AFTER COMPLETION OF THE SETTLEMENT PERIOD AS DETERMINED BY THE CONTRACTING OFFICER'S ENGINEER, THE CONTRACTOR SHALL REMOVE THE ENTIRE SETTLEMENT PLATE ASSEMBLY. ALL COSTS ASSOCIATED WITH PLACEMENT, SURVEY AND REMOVAL OF THE SETTLEMENT PLATES SHALL BE INCLUDED IN THE LUMP SUM BID.

## DETAIL OF PLATE SEATING



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Project:

NEVAL THOMAS ELEM. SCHOOL  
650 ANACOSTIA AVE., NE  
WASHINGTON, DC 20019

Project No.: 2001016.00

Designed by: TR

Drawn by: CO

Title: SETTLEMENT PLATE  
DETAILS AND NOTES

Checked by: MW

Date: 05/12/2003

Modifies Drawing No.: 1/C402 Scale: NTS




Drawing No.: ADD-C-06




Project: NEVAL THOMAS ELEM. SCHOOL  
650 ANACOSTIA AVE., NE  
WASHINGTON, DC 20019  
Title: SITE UTILITIES  
ENLARGED PLAN

Project No.: 2001016.00  
Designed by: TR  
Drawn by: CO  
Checked by: MW  
Date: 05/12/2003  
Drawing No.: ADD-C-07

## GENERAL NOTES

1. ALL CONDUITS, RACEWAYS, CABLE TRAYS, JUNCTION BOXES, BACKBOXES/FLOOR BOXES, JACK BACKBONE AND ALL HORIZONTAL CABLING SHALL BE PROVIDED BY UNDER THIS CONTRACT.  TELECOMM EQUIPMENT NOT IN CONTRACT IS DESIGNATED "NIC". REFER TO SPECIFICATIONS.
2. ALL CABLES SHALL ORIGINATE AND TERMINATE BASED ON THE OUTLET LOCATION AND ASSOCIATED SYMBOL LEGEND AND NOTES.
3. ALL STATION CABLES ROUTED VIA THE CEILING OF FLOOR BELOW SHALL BE BUNDLED SEPARATELY FROM THE CABLES SERVING WORKSTATION OUTLETS ON THAT FLOOR.
4. WORKSTATION CABLING THAT BRANCHES OFF OF THE CABLE TRAY, AND/OR KINDORF FRAMING SHALL BE SUPPORTED USING J-HOOKS OFF OF CEILING SUPPORT HANGERS NO MORE THAN 5 FEET APART TO ELIMINATE CABLE STRESS. BUNDLES SHALL NOT EXCEED 3 IN DIAMETER, AND SHOULD BE TIE WRAPPED NO MORE THAN 6 FEET ON CENTER.
5. TELECOMM JUNCTION BOX/BACKBOX CONDUITS USED TO FEED TELECOMM WORKSTATIONS IN INACCESSIBLE CEILING AREAS SHALL BE EXTENDED TO NEAREST ACCESSIBLE CEILING AREA ON THE SAME FLOOR.
6. NOT USED.
7. NOT USED.
8. NO FURNITURE OUTLET SYMBOLS ARE SHOWN ON THE FLOOR PLANS FOR THE FURNITURE MOUNTED OUTLETS. WHERE A TELECOMMUNICATIONS TAG IS SHOWN ON THE FLOOR PLAN IT SHALL BE UNDERSTOOD THAT A TELECOMMUNICATIONS OUTLET SHALL BE PROVIDED FOR THAT SPECIFIC LOCATION.
9. CONTRACTOR TO MAKE SURE THAT CONDUITS FOR TELECOMMUNICATIONS ARE INTERRUPTED WITH A JUNCTION BOX/PULLBOX (SIZED PER EIA/TIA STANDARDS) AFTER THE SUM OF THE BENDS ADDS UP TO 180 DEGREES. CONTRACTOR TO FOLLOW ALL EIA/TIA STANDARD WHEN PROVIDING THE TELECOMMUNICATIONS INFRASTRUCTURE AND ASSOCIATED REQUIREMENT IN THE ELECTRICAL SCOPE OF WORK.
10. NOT USED. 
11. ALL TELECOMM STATION CABLES SHOULD ORIGINATE AND TERMINATE ON THE SAME FLOOR (U).
12. ALL LOCATIONS IDENTIFIED WITH A TELECOMM OUTLET SHALL BE PROVIDED WITH A BACKBOX AND A 1" STUB-UP CONDUIT TO THE CEILING UN.
13. THE CONTRACTOR SHALL INFORM THE ENGINEER OF ANY DISCREPANCIES THAT ARISE DURING THE SITE VISIT AND SHALL REQUEST CLARIFICATION, IF NECESSARY. 
14. THE DRAWINGS FOR COMMUNICATIONS WORK UTILIZE SYMBOLS AND SCHEMATIC DIAGRAMS WHICH HAVE NO DIMENSIONAL SIGNIFICANCE. THE WORK SHALL, THEREFORE, BE INSTALLED TO FULFILL THE DIAGRAMMATIC INTENT EXPRESSED ON THE COMMUNICATIONS DRAWINGS, BUT IN CONFORMITY WITH THE DIMENSIONS INDICATED ON THE FINAL WORKING DRAWINGS, FIELD LAYOUTS AND SHOP DRAWINGS OF ALL TRADES.

 AMENDMENT NO.3, ISSUED 05/12/2003

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Yaffee  
Prescott



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Project: NEVAL THOMAS ELEM. SCHOOL Project No.: 2001016.00  
650 ANACOSTIA AVE., NE Designed by: DT  
WASHINGTON, DC 20019 Drawn by: EF  
Title: TELECOMMUNICATIONS Checked by: TS  
GENERAL NOTES Date: 05/12/2003  
Modifies Drawing No.: T001 Scale: NONE Drawing No.: ADD-T-02